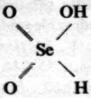
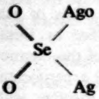
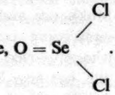
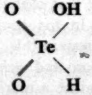
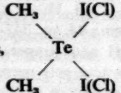
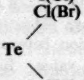
JANUARY, 1941.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

1. Molecular structure of some Se compounds determined by magnetic method. M. PRASAD AND S. S. DHARMATTI. *Proc. Indian Acad. Sci. A*, **12**, *pp.* 185–198, *Aug.*, 1940.—Measurements of magnetic susceptibilities by a modified form of Gouy's balance indicate the following molecular structures:—selenium monobromide (or monochloride), (Cl) Br — Se — Se — Br (Cl); selenious acid (solid).  ; silver selenite,  ; selenysyl chloride,  . C. B. A.

2. Molecular structure of some Te compounds determined by magnetic method. S. S. DHARMATTI. *Proc. Indian Acad. Sci. A*, **12**, *pp.* 212–222, *Aug.*, 1940.—The following structures are indicated:—tellurious acid,  ; telluric acid, probably $Te(OH)_6$; dimethyl tellurium diiodide or dichloride,  ; tellurium dichloride (or dibromide),  . C. B. A.

3. Electron-diffraction investigation of molecular structure of dilead-hexamethyl. H. A. SKINNER AND L. E. SUTTON. *Trans. Faraday Soc.*, **36**, *pp.* 1209–1212, *Dec.*, 1940.—The molecular structure of Pb_2Me_6 has been determined using the electron-diffraction method. AUTHORS.

4. Kinetics of mutarotation in solution. J. C. KENDREW AND E. A. MOELWYN-HUGHES. *Proc. Roy. Soc. A*, **176**, *pp.* 352–367, *Nov.* 1, 1940.—Representative reducing sugars from the pentose, hexose and disaccharide series have been investigated polarimetrically over wide temperature ranges in aqueous solution. The dependence of the velocity coefficient, k, upon temperature is fairly well reproduced by an equation of the form $\ln k = C + (J/R) \ln T - E/RT$. The constants C, J and E, of this equation are discussed, with reference to many reactions, in terms of a theory of unimolecular reactions in solution. AUTHORS.

5. Oxygen ion in oxide glasses. T. ABE. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 647–665, *Aug.*, 1940.—The most probable values of molecular refraction of the glasses in the ternary systems SiO_2-Na_2O-CaO, SiO_2-K_2O-CaO and B_2O_3-Na_2O-SiO_2 were calculated on the assumption that along the lines of constant Na_2O content the molecular refraction varies linearly with the molecular concentration of the oxide in the glass. The ion refraction of an oxygen ion whose distance from the neighbouring cation seems to vary with the composition of glass was calculated as a function of the molecular concentration of Na_2O, and the results indicate that the ion-refraction concentration curve is a measure of the relative difficulty of crystallization of glasses. In the case of glasses in the ternary system B_2O_3-Na_2O-SiO_2 it was found that, where the Na_2O content expressed as a molecular fraction is less or larger than 0·18, the ion refraction of the particular oxygen ion $O^{BIII, BIV}$ is less or larger than that of O^{BIII}, where $O^{BIII, BIV}$ is the oxygen ion belonging simultaneously to a BO_3 triangle and a BO_4 tetrahedron, and O^{BIII} is the oxygen ion which belongs to 2 BO_3 triangles at the same time. It was also shown that the addition of Na_2O to SiO_2 glass results in a continuous increase in the specific volume. In glasses of the ternary system, B_2O_3-Na_2O-SiO_2, boron atoms change from triangular to tetrahedral distribution until ¼ of them have been so changed. The remainder do not alter with further increase in the Na_2O content.

6. Relation between potential energy and interatomic distance in some diatomic molecules. J. W. LINNETT. *Trans. Faraday Soc.*, **36**, *pp.* 1123–1134, *Nov.*, 1940.—The relative advantages of several functions relating the potential energy and the distance between 2 bonded atoms are discussed. The function $V = ar^{-m} - be^{-nr}$ is examined in detail and expressions are obtained from this function inter-relating the observable values of the quantities: k, r_e, D and $\omega_e x_e$. AUTHOR.

✱**7. Molecular weights of rubber and related materials. I. Experimental methods. II. Osmotic pressure and viscosity of solutions of raw rubber.** G. Gee. *Trans. Faraday Soc.*, **36,** *pp.* 1162–1178, *Nov.*, 1940.—A new form of osmometer for use with non-aqueous solutions is described. A method of measuring the vapour pressure lowering produced by a solute from the rate of isothermal distillation of solvent into the solution has been worked out and shown to be applicable to the measurement of molecular weights up to 10000. The calculation of molecular weights from the osmotic pressures of non-ideal solutions is discussed. The basis of the viscosity method of determining molecular weights is critically examined. The osmotic molecular weight of crepe has been measured in several solvents. Viscosity data are employed to calculate absolute weight average molecular weights, the Staudinger constant being determined by comparison with ultra-centrifuge data. Constants are listed for a number of solvents and shown to vary only by a small factor. The osmotic and viscosity molecular weights of a number of rubbers are compared; the 2 values agree for 3 rubber fractions, while for unfractionated materials the viscosity average is the higher. Non-uniformity coefficients are calculated from the ratio of the 2 molecular weights. The molecular weight of " sol " rubber is higher than that of " gel " showing that the sol-gel separation does not arise from molecular weight difference. The Staudinger law is shown to hold for rubber solutions at least over the molecular weight range 350000–60000, and probably very much further. Author.

COLLOIDS.

✱**8. Air-driven ultra-centrifuge.** F. R. Eirich and E. K. Rideal. *Nature, Lond.*, **146,** *pp.* 541–542 *and* 551–552, *Oct.* 26, 1940.—Sedimentation and diffusion constants of macromolecules are conveniently determined with the oil-driven ultra-centrifuge of the Svedberg type, but this machine is not generally available for normal routine laboratory work, and experience is now recorded of work carried out with the air-driven top of Henriot and Huguenard which has been developed in the U.S.A. The highest speed used was 91700 r.p.m. and the inaccuracy was only of the order of 0·1%. Data are given for several proteins, including ovalbumin, cytochrome C, arachis hypogaea (a globulin arachin from the ground nut), and carbonic anhydrase, and sedimentation diagrams are included. Molecular weights of about 15000 are readily determined. H. H. Ho.

9. Optical properties of colloidal suspensions in relation to the measurement of particle-size frequency. E. G. Richardson. *J. Appl. Phys.*, **11,** *pp.* 653–657, *Oct.*, 1940.—The object of this research has been to develop an apparatus in which the light transmitted through a polydisperse suspension of opaque particles during sedimentation was used to derive the size/frequency curve for the solid in question, and a preliminary investigation was made of the manner in which the light extinction varied with particle diameter and concentration. The range of size was from 1 to 0·1 micron. Titanium oxide was used for the calibration of the particle-size meter. Applications of the apparatus are described. H. H. Ho.

10. Measurement of opacity during the coagulation of the concentrated sols of zirconium and stannic hydroxides and the gelation of stannic phosphate and zirconium hydroxide gel-forming mixtures. M. Prasad and K. V. Modak. *Proc. Indian Acad. Sci. A*, **12,** *pp.* 235–244, *Sept.*, 1940.—The transparency method, first employed by Mukherjee and Majumdar for the study of sols undergoing coagulation and modified by Desai who employed a photocell instead of the thermopile, has now been improved. Full experimental details with data curves are given together with a very complete discussion of results. The distinct stages of gelation, often stated as 3 independent processes, did not exhibit their individual existence; the gelation process appeared to be smooth. The fact that coagulation was found to be the first step in the complex process of gelation might be responsible for the similar curves for coagulation and gelation, the latter 2 steps failing to produce a marked effect on the opacity. H. H. Ho.

11. Silicic acid gels. C. B. Hurd and R. W. Barclay. *J. Phys. Chem.*, **44,** *pp.* 847–851, *Oct.*, 1940.—The effect of pH and temperature upon the time of set of very acid gels prepared from sodium silicate and either HCl or H_2SO_4 has been studied. For the range $p\text{H} = +0{\cdot}5$ to $-0{\cdot}5$ there is a linear relation between logarithm of time of set and the pH value. In contrast to the analogous relation at $p\text{H} = 3$ to 6, the time of set increases with increase of pH. A rise of temperature decreases the time of set for these highly acid gels, as is the case in the pH range 3·0 to 6·0. In spite of the greater dehydrating power of H_2SO_4, gel mixtures containing it set somewhat more slowly than those containing HCl. Authors.

12. Sedimentation of suspensions. L. T. Work and A. S. Kohler. *Industr. Engng Chem.*, **32,** *pp.* 1329–1334, *Oct.*, 1940.—Suspensions of calcium carbonate and basic aluminium sulphate with barium sulphate have been studied under a 2- to 3-fold variation of height and over a 7- to 17-fold variation in concentration of solids, and the geometric similarity of the settling curves is shown. This relation is found available for predicting the settling curves for any initial height, provided that a slurry of the desired concentration is settled and the curve for it determined. A graphic method has been developed for determining the settling curve during the falling-rate period for a given slurry of any desired combination. It has further been shown that there are 2 distinct portions to the falling-rate period:—(1) when the sludge is fluid and (2) when the sludge is plastic and undergoing consolidation analogous to that of soils. The relation for the constant-rate period has been derived, based on the absolute velocity of fall against an upward stream of displaced fluid, and this relation is shown to be a composite of the Stokes' law velocity and of a flow restriction factor associated with the close clearances between particles. A pipe flow analogy is presented and indications are given that $Vp/S\mu$ may be used as a Reynolds number for further fundamental analysis in this field.

H. H. Ho.

13. Proof of the thermodynamic stability of materials taken up by solutions containing solubilizers such as soap. J. W. McBain and J. J. O'Connor. *J. Amer. Chem. Soc.*, **62,** *pp.* 2855–2859, *Oct.*, 1940.—Hydrocarbons, such as methylcyclopentane, normally insoluble in water, dissolve to the extent of 0·19 mole/l. in 0·18 mole/l. potassium oleate solution and to an even greater extent in soap solutions containing small additions of silicate or hydroxide. The colloidal solutions formed are thermodynamically stable because the vapour pressure is significantly less than that of the free hydrocarbon until the solution is approximately saturated. Authors.

14. Suspension of solids in mixed liquids. E. W. J. Mardles. *Trans. Faraday Soc.*, **36,** *pp.* 1189–1198, *Dec.*, 1940.—A study has been made of the viscosity and settling of kaolin and other finely divided solids dispersed in several mixed liquids. It has been found that in viscosity and dispersion behaviour the suspensions resemble solutions of cellulose esters, proteins, soaps and other colloidal substances in mixed liquids. Thixotropy and the high viscosity due to aggregation, observed with solids in non-polar liquids such as hydrocarbons, were considerably reduced by the addition of polar molecules such as oleic acid or linseed oil and by the addition of colloidal substances adsorbed by the dispersed solid. Suspensions of higher concentration, and those in non-polar liquids when aggregation is pronounced, are more sensitive to changes in the composition of the dispersion medium and corresponding changes in its polar character. The formation of hydrates and molecular complexes in mixed liquids is accompanied by a fall in the dispersive action, but with some mixtures, although complexes are present, yet molecular disaggregation of the mixed liquids also occurs and maxima and minima were found with some of the property/composition curves for the suspensions in mixed liquids. Author.

See also Abstract 47.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

15. X-ray structure and elastic strains in copper. S. L. Smith and W. A. Wood. *Proc. Roy. Soc. A*, **176,** *pp.* 398–411, *Nov.* 1, 1940.—The X-ray structure of copper has been investigated at a systematic series of points on the load/extension curve and during unloading and reloading from selected points on the curve. It is shown that the permanent strain is associated with the breakdown of the grains into the crystallite formation and that this change is essentially irreversible. The elastic strain of the metal is accompanied by reversible changes in dimensions of the atomic lattice which take place without leaving in the lattice any permanent distortion. Quantitative measurements are made on the elastic lattice strains exhibited by the (400) and (331) planes in a direction perpendicular to the axis of the applied stress, and these are compared with the equivalent external elastic constants. These measurements show that marked difference in rate of strain may take place in neighbouring grains subjected to the same external stress, and on this difference is based an explanation of the extensive breakdown of the grains into components of widely varying orientations which characterizes the structure of a polycrystalline metal after deformation beyond the yield point. Authors.

16. Atomic distribution in aluminium-silver alloys during ageing. C. S. Barrett and A. H. Geisler. *J. Appl. Phys.*, **11,** *pp.* 733–739, *Nov.*, 1940.—Laue photographs of Al-rich Al-Ag crystals during ageing at 20° and 150°C. show more or less clearly defined streaks along certain zonal ellipses, in addition to the streaks caused by thermal agitation. These have been analysed by stereographic and reciprocal lattice projections and are found to result from 2-dimensional gratings parallel to planes of the form {111}. The streaks with 20° ageing are more diffuse than with 150° ageing; no streaks were found with 200° ageing. When the precipitate lattice is fully developed, it yields sharp spots along the streaks at positions predicted from earlier studies of the Widmanstätten structure; preceding this state

there exist very thin plate-like nuclei on randomly spaced {111} planes, which govern the orientation and shape of the fully developed precipitate. These may consist of clusters of Ag atoms or imperfect lattices caused by (111) layers of atoms shifting parallel to themselves as required for the transformation from the face-centred cubic to the hexagonal close-packed lattice but with the shifting occurring on random planes, thus destroying the lattice periodicity normal to these planes.
AUTHORS.

17. Modified reflection of X-rays by crystals: calcite. S. BHAGAVANTAM AND J. BHIMASENACHAR. *Proc. Indian Acad. Sci. A*, **12**, *pp*. 337–339, *Sept*., 1940.—A Raman scattering type of reflection has recently been discovered for X-rays by Raman and Nilakantan [Abstr. 2161 (1940)]. Similar effects have now been observed by the authors by reflecting CuK_α and CuK_β radiation from the cleavage plane (211) of calcite. The positions of these reflected rays have been measured, and the results give values for the spacing which are nearly constant for all the crystal settings studied. These values agree reasonably well with the standard value of 3·029 Å. G. G.

18. Crystal structure of picryl iodide. G. HUSE AND H. M. POWELL. *J. Chem. Soc*., *pp*. 1398–1402, *Oct*., 1940.—The structure of tetragonal crystals of picryl iodide has been investigated by Fourier syntheses from X-ray data. The molecules are related by a 4-fold screw axis and their arrangement approximates to cubic close-packing. The two nitro-groups in the *o*-positions to the iodine atom are rotated so that the 3 atoms in NO_2 lie in a plane almost at right angles to that of the benzene ring; the third nitro-group is coplanar with the ring and its 2 oxygen atoms are related by the 2-fold axis which passes through the molecule. AUTHORS.

19. Determination of the structure of metadinitrobenzene by Patterson-Fourier summation. K. BANERJEE AND M. GANGULY. *Indian J. Phys*., **14**, *pp*. 231–236, *June*, 1940.—Relative values of the integrated intensities of reflections from the *hko* planes have been measured from Weissenberg goniometer photographs by the help of a Zeiss microphotometer. Using needle-shaped crystals much elongated along the *c*-axis, only a single traversal of the scanning spot of light was found necessary and a considerable economy of labour was thus effected. The absolute intensities were obtained by comparison with reflections from rock-salt in a powder photograph of a mixture of known proportion of metadinitrobenzene and rock-salt. From the projections on the (001) plane of the different interatomic vectors in the unit cell obtained by Patterson analysis a preliminary determination of the atomic arrangements has been made. AUTHORS.

20. Structure of multilayers. I. G. KNOTT, J. H. SCHULMAN AND A. F. WELLS. *Proc. Roy. Soc. A*, **176**, *pp*. 534–542, *Nov*. 27, 1940.—X-ray and microscopic examinations of multilayers of certain long-chain esters deposited on transparent bases have been made. An X-ray photograph of a stationary multilayer of ethyl stearate is apparently identical with that obtained by rotating a single crystal of β-ethyl stearate about the long axis of the cell. The spots previously observed on oscillation photographs of multilayers of ethyl stearate are in reality parts of circles, successive arcs of which appear on increasing the angle of incidence of the X-rays on the multilayer. These facts reveal that the multilayer consists of microcrystals all oriented with one axis in common, this axis being the normal to the surface of the multilayer. The single crystals appear to have grown without interruption throughout the entire thickness of the multilayer. AUTHORS.

21. Location of hysteresis phenomena in Rochelle-salt crystals. W. P. MASON. *Phys. Rev*., **58**, *pp*. 744–756, *Oct*. 15, 1940.—Measurements of the elastic properties of an unplated crystal, the piezoelectric constant f_{14} and the clamped dielectric constant, of a Rochelle-salt crystal show that practically all hysteresis and dissipation effects are associated with the clamped dielectric properties of the crystal. A theoretical formulation of the equations of a piezo-electric crystal has been made which takes account of the dissipation effects. The formulation is given for the polarization theory. The frequency variation of the clamped dielectric constant when interpreted by Debye's theory of dielectrics, modified to take account of hysteresis losses, indicates that there are 2 components, one of which has associated with it a high viscous resistance, whereas the other one has not. The non-viscous component is probably due to the displacement of the ions in the lattice structure and the viscous component to the dipoles of the Rochelle salt. AUTHOR.

DENSITY.

See Abstract 50.

DIFFUSION AND OSMOSIS.

22. Permeability of hygroscopic materials to water vapour. I. Observations at relative humidities less than 75%. J. D. BABBITT. *Canad. J. Res. A*, **18**, *pp*. 105–121, *June*, 1940.—Experimental work has shown that for the transpiration of moisture through hygroscopic materials 2 distinct regions of relative humidity can be distuingished: (i) A region below some value be-

tween 70% and 80% where the moisture movement is proportional to the vapour pressure difference, and (ii) a region of high relative humidity where the moisture movement is not directly proportional to the vapour pressure. A theory is advanced that these 2 regions correspond to the 2 conditions in which water may be present in a hygroscopic material: (i) the water may be molecularly adsorbed, i.e. bound by the affinity of the molecules of water for those of the solid on which it is adsorbed; (ii) the water may be held in small fissures in the sub-microscopic structure of the sorbing material by capillary forces. The mechanism by which the moisture will move through the material would be different in the two cases and would result in the distinction between regions of high and of low relative humidity. Measurements are given for fibreboards, showing that below 75% relative humidity the resistance of the board to moisture transpiration is proportional to the thickness. The moisture-content gradients through fibreboard samples have been determined, and indicate that at these low humidities Fick's law is applicable.
AUTHOR.

See also Abstract 7.

ELASTICITY AND PLASTICITY.

23. Similarity of the stress distributions in a circular disc and a square plate. H. ŌKUBO. *J. Appl. Phys.*, **11**, *pp.* 720–723, *Nov.*, 1940.—A solution, suitable for numerical calculations, is derived for the stress distribution in a square plate compressed by a pair of forces acting in the plane of the plate through the mid-points of a pair of opposite sides. The distribution is shown to be similar to that in a circular disc compressed diametrically.
J. S. G. T.

24. Stress analysis by 3-dimensional photoelastic methods. D. C. DRUCKER AND R. D. MINDLIN. *J. Appl. Phys.*, **11**, *pp.* 724–732, *Nov.*, 1940.—Two important limitations of previous developments are removed. A true extension to 3 dimensions is given by the determination of the effect on retardation of appreciable variation in the orientation of the secondary principal stresses in planes perpendicular to the wave normal (such variation being the rule rather than the exception for general states of stress). Also, methods for the analysis of whole planes are presented, thus avoiding the cumbersome and tedious point-by-point procedures that have been advanced. In the particular case of plane stress these methods reduce to a purely optical technique for determining the principal stresses themselves, or more easily their sum, for the entire model.
AUTHORS.

25. Problems of the singing propeller. W. KERR, J. F. SHANNON AND R. N. ARNOLD. *Proc. Inst. Mech. Engrs, Lond.*, **144**, *pp.* 54–76; *Disc.*, 76–90, *Dec.*, 1940.—The unusual noise emanating from what is known as a "singing" propeller is the direct result of the vibration of the blades. These are disturbed by the irregular hydrodynamic actions of cavitation and vortex shedding and induced by the extreme variations in the wake. It is demonstrated experimentally that a blade with a sweeping plan form and sharp edge suppresses cavitation and vortex action within the working range of the propellers. Sharpening the blade edges round the periphery, in a wedge-shaped manner, has been applied successfully as a cure to many singing propellers. In addition to suppressing the disturbing forces, experiments show that the sharp edge provides considerable increase in hydrodynamic damping. The response of the blade to tip and edge excitation is considered. Blade flutter is examined, but it is concluded that such a condition is unlikely. Notes emitted by singing propellers suggest that many modes of flexural, torsional and lateral vibration are present. It is shown that the lateral types respond easily and their importance is indicated by a number of noisy propellers which have exhibited fatigue cracks conforming to the lateral modes of vibration. It is recommended that the process of sharpening the blade edges be adopted, as this suppresses the exciting forces and damps the response of the blade.

26. Vibrations of free plates: isosceles right-angled triangles. M. D. WALLER. *Proc. Phys. Soc. Lond.*, **53**, *pp.* 35–39, *Jan.*, 1941.—The paper describes the results of systematic observations made on the vibrating modes of a free plate which is in the shape of a right-angled isosceles triangle. Any mode of vibration which is possible to this plate corresponds to some natural mode of the square plate, but the converse statement is only true in a restricted number of cases. Thus the only nodal systems of the square plate which have their counterpart on the triangular plate are given by $\omega = u_m(x)u_n(y) + u_n(x)u_m(y) = 0$. The triangular nodal systems differ markedly from the figures which are obtained by cutting the square nodal systems in halves diagonally; the natural frequencies of the triangular plate are appreciably lower than the corresponding frequencies of the square plate, these differences being caused by the changed boundary conditions.
AUTHOR.

27. Some experiments on forced vibrations of varying period. K. SEZAWA AND W. WATANABE. *Rep. Aero. Res. Inst. Tokyo, No.* **195**, *pp.* 215–227, *Aug.*, 1940.—The resonance condition of an elastic bar under the action of periodic forces, with frequency increasing or decreasing linearly with time, was investigated experimentally. The vibration of the same bar was excited electromagnetically, the intensity of the force being constant for every vibration through the whole range of the varying frequency and also for any particular experiments. A magnetic damper was employed for ascertaining the effect of viscous damping on the resonance amplitude. Empirical formulae were evolved giving the resonance amplitude for any rate of frequency variation. AUTHORS.

28. Dynamical stability of a column under periodic longitudinal forces. I. UTIDA AND K. SEZAWA. *Rep. Aero. Res. Inst. Tokyo, No.* **193**, *pp.* 139–183, *Aug.*, 1940.—Experimental and theoretical investigation shows that this problem is dynamically one of instability in free transverse oscillation as well as of resonance in forced longitudinal vibration. Although there are a number of frequencies at which the vibration becomes unstable or resonant, the column vibrates in its fundamental mode almost irrespective of the frequency of applied forces. The conditions in which the vibration in question occurs are such that the ratios of the natural frequency to that of the exciting forces are 1/2, 2/2, 3/2, 4/2, 5/2, etc. The greater the ratio under consideration, the smaller the resonance amplitude and the range of instability. At every resonance condition the change of amplitude for increasing frequency differs from that for decreasing frequency. When the frequency is decreasing the vibration amplitude increases up to a certain limit and then falls to that corresponding to increasing frequency. The resonance condition is shown to depend upon the magnitude of the forces applied If the forces were not great, it would be impossible for the resonance or unstable condition to occur, from which it follows that the phenomena resemble those of resonance vibration with respect to the vibrational frequency and those of buckling with respect to the magnitude of the applied forces. AUTHORS.

***29. Vibrometers having metal diaphragms.** M. MATUDAIRA, T. HAYASAKA AND M. SUZUKI. *Nippon Elect. Commun. Engng, No.* 21, *pp.* 35–38, *July*, 1940.—The vibrating diaphragm of the ordinary vibrometer is a circular wood plate lightly suspended by a thin rubber membrane around its circumference. The present paper reports the results of an attempt to use an all-metal diaphragm for the purpose. S. A. S.

30. Recent research on combined stress. J. J. GUEST. *J. Inst. Auto. Engrs*, **9**, *pp.* 33–72, *Dec.*, 1940.—[See Abstr. 3065 (1940).] Theories and experimental work relating to the fracture of ductile and brittle materials under combined stress are briefly and critically reviewed. Adverse criticisms of the Guest criterion of fracture are considered to be untenable, and it is pointed out that all observations, except 2, made in the researches of the last decade support the Guest law. The work of Cook and of Gough and Pollard affords strong evidence in support of the law. J. S. G. T.

HYDRODYNAMICS AND AERODYNAMICS.

31. Velocity distribution in plane jet. T. OKAYA AND M. HASEGAWA. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 771–780, *Sept.*, 1940.—The velocity distribution in a plane jet is discussed mathematically. Theoretical results for the distribution of the velocity component parallel to the jet axis and for the value of the velocity on the jet axis agree with Förthmann's experimental results [*Ing. Arch*, 1934, **5**, *p.* 42] for air. Expressions are derived for the mixture length and its supplementary factor. J. S. G. T.

32. Wave resistance of a plane plate. Y. NOMURA. *Sci. Rep. Tohôku Univ.*, **29**, *pp.* 268–286, *Sept.*, 1940.—The problem is that of the wave resistance of an infinitely long plane plate and of a circular disc when either is being held vertically below the free surface and is moving in a direction normal to the plate. The wave resistance is found by calculating the resultant of the fluid pressure on both sides of the plate. The couple which tends to make the plate parallel to the velocity is also found by calculating the resultant moment of the fluid pressure about the central line of the plate. The variation of the wave resistance and couple with the velocity is shown. AUTHOR.

LENGTH, AREA AND VOLUME.

***33. Construction and operation of a simple automatic multiple burette.** J. S. TAPP. *Canad. J. Res. B*, **18**, *pp.* 217–222, *July*, 1940.—A simple automatic machine has been designed and built for delivering small measured quantities of liquid at regular intervals of time. The fluid comes in contact with no other material than glass, and hence the apparatus may be used to handle almost all known free-flowing liquids without fear of corrosion of the apparatus or serious contamination of the fluid. The liquid may contain a solute or stable colloidal particles without causing irregular operation through the deposition of solids by evaporation. The design lends itself particularly to handling many different fluids simultaneously, or to delivering measured quantities of a similar fluid at many different places. AUTHOR.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

34. Tables of integrals useful for the calculations of molecular energies. I. M. Kotani, A. Amemiya and T. Simose. **II.** M. Kotani and A. Amemiya. *Proc. Phys.-Math. Soc. Japan*, **20**, *Extra No.* 1, [70 *pp.*], *March*, 1938, *and* **22**, *Extra No.*, [28 *pp.*], *June*, 1940.

MECHANICS, CLASSICAL.

See Abstract 44.

MECHANICS, QUANTUM.

35. Connection between spin and statistics. W. Pauli. *Phys. Rev.*, **58**, *pp.* 716–722, *Oct.* 15, 1940.—The following conclusions are drawn for the relativistically invariant wave equation for free particles: From postulate (I), according to which the energy must be positive, the necessity of Fermi-Dirac statistics for particles with arbitrary half-integral spin; from postulate (II), according to which observables on different space-time points with a space-like distance are commutable, the necessity of Einstein-Bose statistics for particles with arbitrary integral spin. It has been found useful to divide the quantities which are irreducible against Lorentz transformations into 4 symmetry classes which have a commutable multiplication like $+1$, -1, $+\epsilon$, $-\epsilon$ with $\epsilon^2 = 1$. Author.

36. Relativistic self-consistent field for Cu$^+$. A. O. Williams, Jr. *Phys. Rev.*, **58**, *pp.* 723–726, *Oct.* 15, 1940.—An improvement can be made in the Hartree self-consistent field solution of the many-electron atom by substituting the Dirac relativistic 1-electron equation for the Schrödinger 1-electron equation. The numerical solution for the inner shells of Cu$^+$ is outlined, and tables of the resulting energy parameters and charge density distribution are given. The corrections introduced into the charge density distribution are small, except near the nucleus, for this comparatively light ion. The energy parameters are noticeably affected, and the known splitting of the (*p*) and (*d*) energy parameters is shown. Author.

37. Static meson field. G. Wentzel. *Helv. Phys. Acta*, **13**, 4, *pp.* 269–308, 1940. *In German.*—The equations of the meson theory of nuclear forces are solved by a new method, which is applicable to the "static" part, i.e. neglecting the velocity of the heavy particles, and which proceeds by an expansion into descending powers of the interaction constant and is therefore suitable for the case of strong coupling. R. P.

38. Statistical mechanics of 1-dimensional substances. I. T. Nagamiya. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 705–720, *Aug.*, 1940.—The problem is considered of a large number *N* of molecules arranged on a straight line of length *l* and it is assumed that only the neighbouring pairs interact. Three alternative intermolecular potential distributions are postulated, and the statistical treatment is given for each on the basis of (*a*) classical mechanics and (*b*) quantum mechanics. It is found that these 3 cases represent the gaseous, liquid and solid phases. The equilibrium of the three phases is discussed. Author.

PRESSURE.

***39. Quartz membrane manometers of small volume.** C. Kenty. *Rev. Sci. Instrum.*, **11**, *pp.* 377–386, *Nov.*, 1940.—Fused quartz membrane manometers, used as null instruments, have been developed for measuring pressures of Hg or other vapours (or gases) from a few cm. of Hg to 50 atm. with an accuracy of the order of 0·1%. The membranes are sealed on to fused quartz heads, either plane or slightly concave. In the first case the motions of the diaphragms are magnified mechanically by a 3-legged rocker, the 2 outer legs of which rest on fixed bearings and the middle of which rests on the diaphragm. The 3 legs being only slightly out of line, a high magnification (up to 6000) is obtained when a mirror and a long light path are used or a pointer and a microscope are employed. In the second case interferences fringes set up between the diaphragm and the nearby slightly concave quartz surface indicate the motions of the former. These manometers are being used to measure the operating pressures in high-pressure (H-type) Hg lamps. Author.

RELATIVITY AND ETHER.

40. Cinematical relativity. G. C. McVittie. *Observatory*, **63**, *pp.* 273–281, *Nov.*, 1940.—E. A. Milne's cinematical relativity is critically examined. It is shown by illustrations drawn from the theory that appeals are made both to empirical laws and to physical laws, contrary to the claims of the author of the theory. It is pointed out that cinematical relativity differs from general relativity in using groups of co-ordinate transformations instead of differential geometry as its basic starting point. Milne's criticisms of the notion of curvature in general relativity are shown to arise from his attempt to discuss this question in terms of 3-dimensional space instead of the appropriate 4-dimensional space-time. G. C. McV.

SOLUTION.

41. Distribution of isomorphous salts in solubility equilibrium between liquid and solid phases. A. E.

Hill, G. S. Durham and J. E. Ricci. *J. Amer. Chem. Soc.*, **62,** *pp.* 2723–2732, *Oct.*, 1940.—Distribution data for the equilibrium between solid solutions of alums or picromerites and their aqueous solutions are described by the empirical equation $\log R_l = \log K + m \log R_s$, where K is the true distribution constant in terms of activities, and m is a characteristic constant for each system, apparently related to the attraction or repulsion between the two components in the solid phase. Comparison with the theoretical equation $\log R_l = \log K + \log R_s\,(f_1/f_2)_s$ leads to the relation $a_1 = kx_1{}^m$, for the solid phase, between the activity a and the mole fraction x of a component. The relation of the 3 Roozeboom types of distribution for such ternary systems forming continuous solid solutions to the value of m is shown and discussed. The observed distribution constant for all the systems was found to be in good general agreement with that calculated from the solubilities, using an empirical regularity observed for the activity coefficients of sulphates in the ionic strengths involved. N. M. B.

42. Activity coefficients of $CdCl_2$ and $CdBr_2$. R. A. Robinson. *Trans. Faraday Soc.*, **36,** *pp.* 1135–1136, *Nov.*, 1940.—[Abstract 4479 (1939).]

43. Activity coefficients of $MnCl_2$, $CoCl_2$, $NiCl_2$ and $CuCl_2$ in aqueous solution at 25°. R. A. Robinson and R. H. Stokes. *Trans. Faraday Soc.*, **36,** *pp.* 1137–1138, *Nov.*, 1940.

SURFACE PROPERTIES.

44. Theory of adsorption on square lattices. J. K. Roberts. *Nature, Lond.*, **146,** *pp.* 372–374, *Sept.* 14, 1940.—In reply to a paper by Tonks [Abstr. 2912 (1940)] in which earlier work by Roberts was criticized, it is admitted that Bethe's method, which had been used there, may sometimes be a poor approximation. This applies for high densities, when the adsorbed atoms are liable to form a superlattice, if Bethe's method is used only to the first order of approximation. On the other hand, the statement that the method cannot be carried beyond the second order of approximation is refuted by giving the solution to the third order. It is also pointed out that the use of a kinetic method in Roberts' work was not intended to overcome any mathematical difficulties in the statistical treatment but was to take account of the fact that, in the actual adsorption process, statistical equilibrium will, in certain circumstances, not be established. R. P.

45. Heats of adsorption and wetting of mercerized celluloses by sodium hydroxide solutions, water and methyl alcohol. J. L. Morrison, W. B. Campbell and O. Maass. *Canad. J. Res. B*, **18,** *pp.* 168–179, *June*, 1940.—The heats of adsorption and wetting by aqueous NaOH, water and methyl alcohol, have been determined for celluloses mercerized at several different alkali concentrations. A quantity named the "heat of mercerization" has been determined, and it is considered to be a measure of the irreversible effects that distinguish mercerized from standard cotton cellulose, such as changed crystal lattice and enhanced internal surface. The extent of the latter change for the various mercerized celluloses has been shown by the heat-of-wetting measurements with water and methyl alcohol. Authors.

46. Adsorption of water vapour on silica surfaces, by direct weighing. H. M. Barrett, A. W. Birnie and M. Cohen. *J. Amer. Chem. Soc.*, **62,** *pp.* 2839–2844, *Oct.*, 1940.—The adsorption of water vapour at 30° on powdered fused silica, 230–270 mesh, has been determined between 0·01 mm. and 26 mm. pressure. It consists of a rapid, reversible adsorption and a slow, non-reversible sorption, the limit of which could not be reached even after 2 weeks. Treating the silica with acid reduced the reversible adsorption by about 35%. Heating the acid-treated powder to dull red heat reduced the reversible adsorption by an additional 30%. A new method for estimating the approximate area of powders has been employed. From this estimate the reversible adsorption of water vapour at 30° on broken surfaces of fused silica has been determined as 0·1 molecular layers at 1 mm., up to a monomolecular layer at 23·2 mm. A measurement of rate of permanent sorption showed that the rate fell off rapidly during the first 25 min. and then became almost constant at 4×10^{-10} g./cm^2./hr. as if the process were a diffusion of water into the silica. Authors.

47. Application of hydrogen-bridge theory to sorption from solution by silica gel. A. L. Elder and R. A. Springer. *J. Phys. Chem.*, **44,** *pp.* 943–949, *Oct.*, 1940.—Data are presented on the sorption of formic, acetic, propionic, crotonic, benzoic and palmitic acids from solutions in carbon tetrachloride, toluene, nitrobenzene, dioxane and water by use of silica gel. A hypothesis is advanced to account for the results obtained, based on the formation of hydrogen bridges. A semi-quantitative explanation of the results depends on at least 3 factors: the relative extent of hydrogen bridging by the different acids, the size and shape of the acid molecules, and the relative extent of formation of hydrogen bridges by solute, solvent and gel. The presence of an unsaturated linkage in an aliphatic acid gives rise to certain abnormalities in the sorption, which afford further proof of the correctness of the hydrogen-bridge hypothesis. Authors.

48. Calculation of surface tension from intermolecular forces. J. E. Lennard-Jones and J. Corner. *Trans. Faraday Soc.*, **36,** *pp.* 1156–1162, *Nov.*, 1940.—A discussion is given of the surface tension of liquids in terms of intermolecular forces. It is shown that certain empirical laws, which have been used extensively in the past, have a certain theoretical basis and can be deduced under certain conditions from intermolecular forces. There is a discussion of the parachor and some of its properties and a formula is given for it in terms of the constants of intermolecular fields. Authors.

49. Surface tensions of amino-acid solutions as a function of *p*H. J. W. Belton and A. H. H. Twidle. *Trans. Faraday Soc.*, **36,** *pp.* 1198–1208, *Dec.*, 1940.—The surface tensions of aqueous solutions of glycine, alanine, valine, cystine and hippuric acid, to which either hydrochloric acid or sodium hydroxide had been added, have been measured; the results are given in the form of the surface-tension/*p*H curve at constant amino-acid concentration. The thermodynamic theory of such systems is given and the form of the curves interpreted in terms of the adsorption of the various components at the surface; it has been found possible to calculate the surface excess for various portions of the curves. Those acids which lower the surface tension of water show a minimum or a maximum surface tension at the *p*H corresponding to pure aqueous ampholyte, while for those which increase the surface tension of water this *p*H corresponds to a point between a maximum and a minimum; investigations on protein solutions also agree with this conclusion which is shown to be in agreement with theory. The influence of sodium chloride has also been investigated. Authors.

50. Properties of liquids in fine capillaries. I. Surface tension and density. L. H. Cohan and G. E. Meyer. *J. Amer. Chem. Soc.*, **62,** *pp.* 2715–2716, *Oct.*, 1940.—The surface tensions of water and toluene were measured in capillaries of radii as small as 2μ. The results indicate that the surface tensions and densities of these liquids do not vary from their normal values within the limit of accuracy of the experiments (± 5%). According to this evidence increase in surface tension cannot be accepted as the explanation for the abnormal vapour pressure lowerings found by Shereshefsky. Authors.

51. Gelation phenomena in wheat-flour films. J. D. Hamilton. *Canad. J. Res. B*, **18,** *pp.* 194–202, *July*, 1940.—Empirical equations describing the behaviour of wheat protein films studied by means of the hydrophil balance technique are presented. Evidence is given which shows that the protein forms a gel when the film area is decreased and that degelation occurs when the area is expanded. A theoretical picture of gel structure is developed to account for the phenomena characteristic of gelation and degelation. Two major assumptions are used: the protein micelles in the gelled condition and in the film stage are in equilibrium only when the film micelles are closely packed and oriented in such a position that the binding force between the film micelles and the aqueous substrate is perpendicular to the water surface. From these assumptions the general form of the gel term is deduced and it is then shown that gels in the form of logarithmic spirals satisfy the physical and theoretical conditions. Author.

52. Image and van der Waals forces at a metallic surface. J. Bardeen. *Phys. Rev.*, **58,** *pp.* 727–736, *Oct.* 15, 1940.—Calculations, based on a model which takes the structure of the metal into account, indicate that the force on an electron outside the surface of a metal is just the classical image force, but that the van der Waals force on a neutral molecule may be smaller than that given by a semi-classical calculation based on the method of images. An approximate value for the van der Waals energy between 2 systems A and B is obtained by calculating the energy of B in the field of A, supposing that the electrons of A are in fixed positions. The result is then averaged over the co-ordinates of the electrons of A, giving an energy W_A. Systems A and B may be reversed in the above calculation and an energy W_B be found. The true van der Waals energy is given roughly by $W_A W_B/(W_A + W_B)$. This method gives a new approximate formula for the van der Waals interaction between 2 molecules, which reduces to a well-known result when further approximations are made. Author.

***53. Measurement of gloss.** L. A. Wetlaufer and W. E. Scott. *Industr. Engng Chem.* (*Analytical Edition*), **12,** *pp.* 647–652, *Nov.* 15, 1940.—Previous investigators have attempted to correlate so-called "gloss" measurements of surfaces with visual observations of the surfaces. Inherent gloss, however, is only one factor in the appearance of a surface and, in order to measure it, it is necessary to prepare paint films such that the inherent gloss is the only factor in the measurement. A refined method of preparing paint surfaces for measurement—namely, doctor-blading on plate glass—is introduced to control or eliminate extraneous factors affecting goniophotometric measurements and visual observations of inherent gloss. The construction of a goniophotometer for research work on gloss in the finishes field and other fields is described and complete specifications are given. Authors.

∗54. Simplified distinctness-of-image glossmeter. R. J. Myers. *Industr. Engng Chem.* (*Analytical Edition*), **12,** *pp.* 678–681, *Nov.* 15, 1940.—A glossmeter has been designed and constructed to measure the distinctness-of-image gloss of painted surfaces. While the theory of the instrument is based upon the existence of minute irregularities on, in or beneath the surface of the paint film, the data collected thus far do not prove that distinctness-of-image gloss is solely affected by the presence of such irregularities. The instrument is flexible in application and has been found valuable in various problems dealing with a gloss denoted as distinctness-of-image gloss. Author.

VISCOSITY AND FRICTION.

55. Viscosity characteristics of lubricating oils as related to their chemical structure. B. Yamaguchi. *Rep. Aero. Res. Inst. Tokyo, No.* **192,** *pp.* 109–136, *Aug.*, 1940. *In Japanese.*—The author explains why no definite relation exists between the chemical structure and the viscosity index of high-molecular-weight hydrocarbons. It is shown theoretically and experimentally that the viscosity/temperature coefficient at the same viscosity of liquids is a unique function of their chemical structure. For a number of synthetic high-molecular-weight hydrocarbons, the viscosity/temperature coefficients at the same viscosity of 100 centistokes have been calculated by means of Walther's viscosity/temperature equation, and it has been substantiated that the coefficients thus calculated are always correlated with the chemical structure of the hydrocarbon. A " structure viscosity index " is defined which makes it possible to predict what molecular structure is required for a hydrocarbon to have the best viscosity characteristics. It is shown that the viscosity characteristics of commercial mineral and fatty lubricating oils, and the effect of adding such an agent as paratone, can be explained on the idea of a structure viscosity index. Author.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

∗56. 48 in. Schmidt telescope for California Institute of Technology. F. E. Ross. *Astrophys. J.*, **92,** *pp.* 400–407, *Nov.*, 1940.—The colour aberrations of the 48 in. Palomar Schmidt telescope have been computed for a number of wavelengths and have been combined in accordance with the spectral sensitivity range of various photographic emulsions. The variation of colour aberrations with the arbitrary parameter k has been studied. A lens for flattening the field has been computed and its colour and field characteristics studied. Author.

COMETS AND METEORS.

57. Accuracy of meteor radiants. R. A. McIntosh. *J. Roy Astr. Soc. Can.*, **34,** *pp.* 373–382, *Oct.*, 1940.—The publication of a statistical analysis of the meteor radiants observed by the Harvard Meteor Expedition focused attention upon the errors inherent in meteor observing and radiant deduction, which were indicated to be much larger than had been believed previously. The formulae of the statistical analysis were based upon the belief that observational errors of ± 8 deg. found in the Harvard data were normal, while many arbitrary assumptions were necessary. Recent papers have revealed that such errors are not common to other meteor workers. A set of New Zealand meteor records is examined along the lines suggested by Öpik, and it is found that the published deductions are confirmed. Author.

58. Relative frequencies of meteors. J. D. Williams. *Astrophys. J.*, **92,** *pp.* 424–433, *Nov.*, 1940.—On the assumption that the number of meteors increases logarithmically with their magnitudes, the base κ is evaluated from a series of binocular observations by the method of maximum likelihood. The reliability of the value so found is discussed, following which an estimate is made of the space density of meteoric material. Author.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

59. Dynamics of stellar systems. B. Lindblad. *Stockholms Obs. Ann.*, **13,** 5, [32 *pp.*], 1940. —The author states the problem as a statistical one; it is an investigation of the forms of the function f which correspond to conditions of equilibrium, and the principle used is the process of mixing. The work of Poincaré, Eddington, Charlier, Jeans, Chandrasekhar and others, is referred to. Finally, the instability of rotating stellar systems is discussed, and it is found to lead to the development of spiral structure; the transition from closed ellipsoidal systems to systems of spiral structure has been found to occur at a ratio of the axes about 0·3 which corresponds to the eccentricity 0·95. In the case of a disturbance due to accidentally ejected matter there may be a real spiral arm formed, and this may lead to the types of barred spirals. A. S. D. M.

60. Dynamics of stellar systems. IX–XIV. S. CHANDRASEKHAR. *Astrophys. J.*, **92**, *pp.* 441–642, *Nov.*, 1940.—The cinematical characteristics postulated are the same as in the earlier paper [Abstr. 3184 (1939)], except for the assumption of the steady state, which is now dropped. In the analysis it is assumed that the coefficients of the velocity ellipsoid, the motions of the local centroids and the density function, are all continuous functions of position and time, arbitrary in the first instance. The general dynamical problem is formulated. It is shown that the mathematical problem reduces to a consideration of 3 groups of equations: (i) a set of 10 simultaneous partial differential equations involving the derivatives with respect to the space co-ordinates of the coefficients of the velocity ellipsoid only; (ii) a set of 6 equations which determine the motions of the local centroids in terms of the time derivatives of the coefficients of the velocity ellipsoid and explicitly in its dependence on the space co-ordinates; (iii) a set of 4 equations which leads to 6 other integrability conditions that can be expressed as 2 vector equations. The explicit solutions of the first 2 sets of equations in a Cartesian system of co-ordinates are given. The general solution of the 16 equations is seen to involve 20 arbitrary functions of time and 6 constants of integration. The 2-dimensional problem is considered in polar co-ordinates. The complete enumeration of stellar systems in non-steady states which have a circularly symmetrical potential function V is made. A critical case is considered which corresponds to the gravitational field arising from a central mass together with a uniform distribution of mass. The enumeration of stellar systems with a spherically symmetrical potential V is made. The general theory of stellar systems for which the equipotential surfaces are concentric ellipsoids is worked out under non-steady-state conditions. In the general case the solution is found to involve 21 constants of integration. The general theory of stellar systems in non-steady states and described by a spherical distribution of the residual velocities is considered. Finally, the problem of specifying the circumstances under which a stellar system can be regarded as consisting of several independent subsystems, each of which satisfies the fundamental cinematical postulates, is dealt with.

NEBULAE.

61. Physical processes in gaseous nebulae: collisional excitation of nebulium. M. H. HEBB AND D. H. MENZEL. *Astrophys. J.*, **92**, *pp.* 408–423, *Nov.*, 1940.—Target areas for collisional excitation of O_{III} by electron impact are calculated by wave-mechanical methods. Coulomb wave functions are used for the colliding electron. The resulting target areas are large, particularly for excitation between the levels of ^3P. Application to the nebulae leads to the result that collisional de-excitations from $^3P_2$ predominate over the spontaneous transitions. In consequence, the levels of $^3P_2$ attain a high population. The figures also suggest, for the lower electron densities of interstellar space, a high population of atoms in the ground level. AUTHORS.

STARS.

62. Variation of Delta Scuti. T. E. STERNE. *Proc. Nat. Acad. Sci. Wash.*, **26**, *pp.* 537–541, *Sept.*, 1940.—Neither light nor radial-velocity curves of δ Scuti are regularly periodic or change continually, but their changes are correlated so that the range of variation in light gives a period of $95\overset{d}{.}247\,7$, and Fath suggested an interference period derived from the fundamental, $0\overset{d}{.}193\,77$, and a secondary of about $0\overset{d}{.}201\,20$, these getting into step every $5\overset{d}{.}247\,74$. The purpose of this note is to indicate the bearing of Fath's recent results on the pulsation theory. The 3 observed periods are in the ratio 1 : 0·812 : 0·491. From photo-electric observations made in different longitudes Fath has found that the secondary period is probably $0\overset{d}{.}157\,382$ and there is a persistent 3rd period of $0\overset{d}{.}095\,156$; the periods and the fundamental $0\overset{d}{.}193\,770$ are interpreted as the 3 largest periods of radial oscillation. He shows what must be done for a completer comparison with the pulsation theory and with the density distribution. A. S. D. M.

63. Systematic and accidental errors of spectroscopic parallaxes. H. N. RUSSELL AND C. E. MOORE. *Contr. Mt. Wilson Obs.*, *No.* 636. *Astrophys. J.*, **92**, *pp.* 354–391, *Nov.*, 1940.—The stars for which trigonometric and spectroscopic parallaxes are available were divided into 8 groups of approximately equal number, in order of the " reduced " spectroscopic parallaxes and of the reduced proper motions, and the mean reduced spectroscopic and trigonometric parallaxes were compared. The deviations from linear correlation between the two are no larger than can be attributed to the accidental and sampling errors—both for the biased and impartial groupings and also for 4 ranges of spectral class among main-sequence stars, for all these together, and for giants. To distinguish between the results of the assumptions of linear correlation between the absolute magnitudes and between the reduced parallaxes would demand several times the observational data now available (1 140 stars). For stars differing greatly in absolute magnitude from the general mean (such as Groombridge 1830) these linear correlations are probably invalid; and the data are at present insufficient for a reliable calibration. The dispersion constants for the reduced parallaxes have been redetermined by analysis of these mean values and compared with those obtained by an earlier correlation analysis. Unavoidable deviations of spectroscopic absolute magnitudes from the true values may arise from physical causes within the stars, such as differences in the relative abundance of hydrogen and heavy elements, either in the interior or in the atmosphere, and differences in the contribution of negative hydrogen ions to the general opacity. These differences may account for a considerable portion of the apparent errors of spectroscopic parallaxes. AUTHORS.

64. Proper motions in the galactic cluster Messier 39. E. G. EBBIGHAUSEN. *Astrophys. J.*, **92**, *pp.* 434–439, *Nov.*, 1940.—Proper motions are derived from Yerkes plates for an area of about 30′ diameter centred on the cluster M 39. The spectral diagram of the cluster is given.

65. Light-curve of ζ Aurigae. W. H. CHRISTIE. *Contr. Mt. Wilson Obs. No.* 635. *Astrophys. J.*, **92**, *pp.* 392–395, *Nov.*, 1940.—The light-curve of ζ Aurigae has been derived from photographic observations made with the 10 in. Cooke refractor combined with measures made elsewhere. The observations can be well represented, within the errors of observation, by a light-curve computed on the assumption that the B-type star is undarkened at the limb and that the limb of the K star is sharply defined. AUTHOR.

66. Spectroscopic observations of Barnard's variable in Messier 3. A. H. JOY. *Contr. Mt. Wilson Obs. No.* 637. *Astrophys. J.*, **92**, *pp.* 396–399, *Nov.*, 1940.—The velocity curve of Barnard's variable star in the globular cluster M3 has been derived from 15 spectrograms. AUTHOR.

67. Internal temperature of white dwarf stars. R. E. MARSHAK. *Astrophys. J.*, **92**, *pp.* 321–353, *Nov.*, 1940.—Accurate expressions for the radiative and conductive opacity are derived, both for the non-degenerate envelope and the degenerate core of the stars. It is shown that the energy transport is chiefly by radiation in the envelope and by electronic conduction in the core. It is found that in the transition region between degeneracy and non-degeneracy the atoms are only partially ionized, whereas both in the envelope and in the core the ionization is almost complete. Quantitative calculations are performed for Sirius B and 40 Eridani B; of the two the observational material is better for Sirius B, so that most attention is paid to this star. The extension of the non-degenerate envelope and the internal temperature are calculated for several widely different assumptions regarding the chemical composition of the star as well as possible errors in the observed luminosity L and the radius R. It is concluded that no appreciable number of protons and no hydrogen are present in white dwarfs. A further conclusion is that the energy production of the white dwarfs is not due to thermonuclear reactions at all but to gravitational contraction. With this source of energy it will be at least 10^8 years before the white dwarfs become dark objects. [See Abstr. 1550 (1939).] AUTHOR.

68. Galactic and extragalactic studies. X. Note on latitude effect and radial gradients in the northern galactic hemisphere. H. SHAPLEY AND R. B. JONES. *Proc. Nat. Acad. Sci., Wash.*, **26**, *pp.* 599–604, *Oct.*, 1940.–In the present discussion earlier results are corroborated. [Abstr. 3100 (1940).]

GEOPHYSICS.

LAND, PHYSICS OF THE

69. Negative pressure and moisture content of a Punjab soil. D. C. MIDHA. *Proc. Indian Acad. Sci. A*, **12**, *pp.* 270–273, *Sept.*, 1940.—Previous results had shown that the negative pressure in soil, due to the extraction of water by plants, depends on the nature of the soil and its moisture content. Tests were made on soils of the Punjab, the negative pressure being measured by a manometer while the moisture content was obtained by drying the soil. It was found that the negative pressure was almost constant to 20% moisture content of the soil, but with lower values the negative pressure increases more rapidly. Methods of avoiding errors are given. R. S. R.

METEOROLOGY.

70. Variations of the amount of carbon dioxide in different air currents. G. S. CALLENDAR. *Quart. J. Roy. Met. Soc.*, **66**, *pp.* 395–400, *Oct.*, 1940.—A brief review is given of the present state of knowledge concerning the variations of atmospheric CO_2, together with some observations which appear to show that the amount of this gas in the air has increased of late years. AUTHOR.

71. Proposed standard solar-radiation curves for engineering use. P. Moon. *J. Franklin Inst.*, **230**, *pp.* 583–617, *Nov.*, 1940.—The paper correlates some of the data available and specifies a proposed standard spectral-distribution curve for sunlight outside the atmosphere. Methods are given for the calculation of the spectral irradiation curve for any elevation above sea level and for any air mass, and these methods lead to proposed standard curves to be used in engineering calculations dealing with direct sunlight at sea level. These curves are checked against independent data on total irradiation, ultra-violet irradiation, illumination and colour temperature. In all cases the agreement between calculated and experimental results gives confidence in the validity of the proposed curves for various engineering applications. Author.

72. Determination of sea-level isotherms, with special reference to S. Africa. T. E. W. Schumann and J. J. le Roux. *Quart. J. Roy. Met. Soc.*, **66**, *pp.* 411–418, *Oct.*, 1940.—The first part contains a discussion of the application of the method of least squares for calculating vertical temperature gradients and thus reducing temperatures, recorded at station level, to sea level. The second part is devoted to a discussion of the results. Apart from S. Africa, the lapse rates for India and the Western and Eastern U.S.A. were also calculated, 40–50 representative stations being selected in each area. For S. Africa the temperature-influencing factors of altitude, latitude and rainfall, are considered simultaneously, whereas for India and the U.S.A. only the factors of altitude and latitude are taken into account. The values both of the lapse rate and of the variation of temperature with latitude are represented graphically, and explanations are offered for their seasonal variations. Authors.

73. Meteorological and soil factors affecting evaporation from fallow soil. H. L. Penman. *Quart. J. Roy. Met. Soc.*, **66**, *pp.* 401–410, *Oct.*, 1940.—The mean daily rates of evaporation from a block of fallow soil at Rothamsted are examined for 94 periods varying in length from 13 to 45 days. In seeking correlations with single daily meteorological observations 2 types of treatment are employed: The year is considered in 3 seasons of 4 months each—summer, winter and two equinoctial pairs of months—and it is shown that an almost complete description of evaporation can be obtained in terms of rainfall only, the nature of the correlation varying from season to season. A general treatment is attempted in physical terms, regarding evaporation as due to diffusion across a non-turbulent boundary layer whose thickness is determined by wind velocity, the soil surface being assumed to be continuously at 100 per cent R.H. The considerable scatter in the data is attributed partly to the inadequacy of single daily meteorological observations but chiefly to the lack of knowledge of the conditions existing at the soil surface. Author.

74. Cycles of pressure, especially in the neighbourhood of symmetry points. L. W. Pollak. *Quart. J. Roy. Met. Soc.*, **33**, *pp.* 419–437, *Oct.*, 1940.—Schuster's criterion and the theory of probabilities have established extraordinarily few meteorological periods. The reason for the failure of periodogram analysis is that it is not applicable to damped oscillations. On the other hand, symmetry points in pressure variations appear to indicate cycles of some persistency and some short series have been analysed by Fuhrich's self-correlating method, of which a short summary is given. The importance of Brunt's criterion for utility has been shown by applying it to the periods of the motion of the earth's pole. Fuhrich's criterion for reality is then treated and several features are discussed—independence of the analysis interval, the representation of artificial functions and the case of equal amplitudes. Sixteen analyses of the pressure variations near symmetry points have been summarized, and it is found that a duration including 2 or 3 cycles when analysed by Fuhrich's method yields a good representation of the variations with a correlation coefficient exceeding 0·8 between the observed and calculated data. The method appears capable of giving at times a forecast of the pressure for 10 to 14 days in winter in central Europe. Author.

75. Relation of recent glacier recessions to prevailing temperatures. J. B. Kincer. *Mon. Weat. Rev., Wash.*, **68**, *pp.* 158–160, *June*, 1940.—Reports of glacier movements in France, Iceland and British Columbia, show that a recession set in about the middle of the 19th century. Long-term temperature records at stations in U.S.A., Europe and Cape Town, show a similar trend towards higher mean values from about the same time. The validity of the temperature normals arises. The standard period taken, 1875–1921, covers low temperatures in the first part of the period and relatively high temperatures in the latter part. Any other period would give values too high or too low. This long-term climatic trend has much economic significance, especially agronomic. R. S. R.

76. 80-year temperature record. C. J. Root. *Mon. Weat. Rev., Wash.*, **68**, *pp.* 157–158, *June*, 1940.—Temperatures are available for Marengo, Ill., in a continuous series with only 1 change of observer and 1 of site. The winter (Dec.-Feb.) temperatures are expressed in 5-year and 10-year periods. There is definite evidence of a cold period 1872–1905 and a warm period 1906–1937. For individual years the variations from normal are changeable, there being only 1 occasion (1930–5) with more than 4 consecutive winters above normal and only 2 occasions (1883–8 and 1900–4) with more than 4 consecutive winters below normal. R. S. R.

SEISMOLOGY.

77. Bibliography of seismology. E. A. HODGSON. *Publ. Dom. Obs. Ottawa*, **13**, *pp.* 91–103, *April–May–June*, 1940.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

78. Recombination and electron attachment in the F layers of the ionosphere. F. L. MOHLER. *Bur. Stand. J. Res., Wash.*, **25**, *pp.* 507–518, *Nov.*, 1940.—Observational data for the ionosphere at Washington have been used as a basis for computations. The rate of recombination at night is roughly proportional to the square of the electron concentration, but the apparent recombination coefficient, α', tends to increase with decreasing electron concentration over the half-period of a sunspot cycle. This fact and the observed variation of α' with height indicate that electrons disappear both by recombination and by negative-ion formation. The daily variation of electron concentration indicates that the F_2 level is far above the level where the rate of production of electrons is a maximum in midsummer and that the F_1 layer is near the level where the rate is a maximum. If α' is a function of the pressure, there will be a maximum electron concentration at a pressure p, given by the relation $p/p_0 = (\alpha/\alpha')f(\lambda)$, where p_0 is the pressure at the F_1 level, α is the electronic-recombination coefficient and λ is the ratio of negative ions to electrons. $f(\lambda)$ is 1, if λ is small, or a linear function of p. In midsummer p is 4×10^{-8} mm. of mercury. $p/p_0 = 0{\cdot}027$ and $\alpha = 2 \times 10^{-12}$, in good agreement with the theory of recombination. A seasonal variation of p/p_0 can be explained, if $f(\lambda)$ is not always unity, as λ is very sensitive to temperature. AUTHOR.

79. Injuries caused by lightning. J. F. SHIPLEY AND P. E. BARNES. *Quart. J. Roy. Met. Soc.*, **66**, *pp.* 389–394, *Oct.*, 1940.—The usual electrical stress in the atmosphere, of about 130 V/m., may increase rapidly in cumulus or cumulo-nimbus clouds and there takes place, specially at high altitudes, a brush discharge which is capable of causing injury. When the electrical stress reaches the order of 10 000 V/cm. a lightning flash may take place. The bodily effects of the brush discharge and of the main current are classed in order of their seriousness, from a tingling of the skin to fatal injuries. The study of these effects is hampered by various factors: ignorance of some of the many conditions, lack of skilled observation, preconceived ideas of witnesses and unsuitability of the circumstances for accurate observation. The best treatment for injured persons is artificial respiration. Lightning storms may indirectly cause severe epidemics. G. E. A.

RADIOACTIVITY.

80. Radioactive isotopes of vanadium. L. A. TURNER. *Phys. Rev.*, **58**, *pp.* 679–681, *Oct.* 15, 1940.—Consideration of the experimental facts concerning the active V of a half-life of 600 days leads to the conclusion that it should be attributed to V^{49} rather than to V^{47} as hitherto proposed. The relatively low yields of V^{50} in the (d, n) reaction and of V^{52} in the (α, p) reaction suggest the existence of not yet discovered long-lived isomers of these nuclei. AUTHOR.

81. Decay of the 4·5 hr. Br^{80} isomer. D. DEVAULT AND W. F. LIBBY. *Phys. Rev.*, **58**, *pp.* 688–692, *Oct.* 15, 1940.—Evidence of a limit of 85 ± 4% to the chemical extractability of the 18 min. Br from its 4·5 hr. parent isomer is presented. This is interpreted as the fraction of 4·5 hr. Br which emits conversion electrons. In agreement with Grinberg and Roussinow, γ-rays of about 30 to 40 ekV average energy were found coming from the 4·5 hr. Br. It does not seem possible to make a unique interpretation yet. The presence of a γ-ray accompanying the 18 min. period is confirmed, but its energy is placed above 0·6 eMV. AUTHORS.

82. Passage of uranium fission fragments through matter. W. E. LAMB, JR. *Phys. Rev.*, **58**, *pp.* 696–702, *Oct* 15, 1940.—Ranges and rates of energy loss of the fission fragments of U are calculated on the basis of a model in which the charge of the fragment is obtained from its energy and its successive ionization potentials. The energy loss cross-section for protons of the same velocity is then used to calculate the ranges of the 2 groups of fragments. These are in fair agreement with the observed ranges. The experimental and theoretical range/energy relations are also in fair agreement. The validity of the model is discussed in detail, and it appears that it should be fairly good for fragments above 5 eMV. The density of ionization is found to decrease along the track, in marked contrast to the behaviour for protons and α-particles. AUTHOR.

83. Internal pair production in radium C′. R. THOMAS. *Phys. Rev.*, **58,** *pp.* 714–715, *Oct.* 15, 1940.—Ra C′ shows a sharp line of 1·4 eMV conversion electrons with no corresponding quanta. The nuclear transition therefore is probably between states of zero angular momentum and like parity. The ratio of pair production to internal conversion of both *K* electrons is computed for this process. Various approximations to the complicated exact formula are given for different *Z* values. AUTHOR.

84. Artificially radioactive element 85. D. R. CORSON, K. R. MACKENZIE AND E. SEGRÈ. *Phys. Rev.*, **58,** *pp.* 672–678, *Oct.* 15, 1940.—Bismuth bombarded with 32 eMV α-particles becomes radioactive. Two ranges of α-particles are emitted, one of 6·55 cm. and one of 4·52 cm. ; these are not genetically related. There are also X-rays which show the absorption characteristics of polonium X-rays. All these radiations separate together chemically as element 85, and all show the same half-life of 7·5 hr. The probable explanation of these effects is the following : Bi^{209}, by an (α, 2*n*) reaction, goes to 85^{211}, which decays either by *K*-electron capture to actinium C′(Po^{211}) or by α-particle emission (range 4·5 cm.) to Bi^{207} The 6·5 cm. α-particles are those of actinium C′. According to this scheme the second branch from 85^{211} leads to Bi^{207} which should decay to Pb^{207}. AUTHORS.

85. Search for resonance-scattered protons from B^{11} and F^{19}. W. R. KANNE, R. F. TASCHEK AND G. L. RAGAN. *Phys. Rev.*, **58,** *pp.* 693–695, *Oct.* 15, 1940.—Preliminary work in search of the resonance scattering of protons from B^{11} and F^{19}, at the lowest energy resonance in each case, is reported. Such scattering was not observed, but upper limits for it are established and a sensitive method for observing small deviations from Rutherford scattering is described. The proton energy producing the resonance in B has been determined to be 163 ± 6 ekV. AUTHORS.

86. Disintegration of ^{13}N nucleus. Y. WATASE. *Proc. Phys.-Math. Soc. Japan,* **22,** *pp.* 639–646, *Aug.*, 1940.—From the analysis, according to the Gamow-Teller conception of β decay, of the experimental results of Kikuchi and his collaborators when investigating the spectra of β- and γ-rays by the disintegration of ^{13}N, the excitation energies, the parities and the possible spins of the low-lying terms of ^{13}C, were determined. The level scheme thus obtained is in disagreement with the predictions based on the individual-particle model or the α-particle model. AUTHOR.

87. Scattering of α-particles by carbon and oxygen. A. J. FERGUSON AND L. R. WALKER. *Phys. Rev.*, **58,** *pp.* 666–671, *Oct.* 15, 1940.—The scattering of α-particles by carbon and oxygen has been observed at large scattering angles, with solid targets and RaC′ as a source. The results show resonances in carbon at energies of 5·5, 5·0 and 4·4 eMV and indicate that the angular momentum quantum number of the compound nucleus O^{16} is probably 2 for the highest level, and greater than zero for the others. Two resonances have been observed in oxygen at energies of 6·5 and 5·5 eMV. These indicate excited states of Ne^{20} whose angular momentum is probably unity. These two levels correspond very closely with those found by Bonner in the disintegration of F by deuterons. AUTHORS.

88. Expressions for calculating the absorption of γ-rays and X-rays. J. TANDBERG. *Ark. Mat. Astr. Fys.*, *27B*, 3, [7 *pp*.], 1940.—The formula for the intensity absorbed by a flat plate of uniform absorption coefficient from a divergent beam of given angle of divergence is given an approximate form which is suitable for numerical evaluation. The corrections due to scattering, Compton effect and other causes, are also discussed. R. P.

RADIATION.

EMISSION.

89. Cosmic ray observations made on the U.S. Antarctic expedition in co-operation with the Bartol Research Foundation. S. A. KORFF AND E. T. CLARKE. *J. Franklin Inst.*, **230,** *pp.* 567–581, *Nov.*, 1940.

90. Measurement of cosmic rays at Agra and Kodaikanal. A. K. DAS AND M. SALARUDDIN. *Indian J. Phys.*, **14,** *pp.* 191–205, *June*, 1940.—Cosmic-ray intensities have been measured at Agra and Kodaikanal by means of a Kolhörster apparatus with a shield of iron 5·5 in. thick. The intensities have been reduced to standard pressures, for Agra and Kodaikanal separately, by means of the regression coefficients calculated from the intensity and pressure data. From the results, after allowing for latitude effect, the absorption coefficient of cosmic rays has been calculated. From this coefficient the absolute intensities of cosmic rays without shield have been deduced. The intensity data for Agra and Kodaikanal are then analysed according to mean and sidereal times. The curves for the mean solar time for the two stations agree with each other and with the corresponding curves of other investigators, but no similarity has been found between the sidereal-time curves of the two stations. Mean daily cosmic-ray intensities have been correlated with solar activity represented by sunspot numbers and flocculi figures, but no relationship has been found to exist between them. AUTHORS.

91. Latitude effect of extensive cosmic-ray showers. H. V. NEHER AND W. H. PICKERING. *Phys. Rev.*, **58**, *pp.* 665–666, *Oct.* 15, 1940.—Measurements of large cosmic-ray shower intensities have been made on the Pacific Ocean. Because of the statistical fluctuations of the experimental results, no positive conclusions regarding the latitude effect for these showers can be reached. AUTHORS.

FLUORESCENCE & PHOSPHORESCENCE, LUMINESCENCE AND AFTERGLOW.

92. Fluorescence analysis. V. Fluorescence detection. I and II. H. GOTÔ. *Sci. Rep. Tohôku Univ.*, **29**, *pp.* 204–218 *and* 287–303, *Sept.*, 1940.—The fluorescence detection of 21 metallic ions has been investigated by the application of various reactions to solutions under exposure to ultra-violet rays. AUTHOR.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

93. Quenching of resonance radiation of sodium. R. G. W. NORRISH AND W. M. SMITH. *Proc. Roy. Soc. A*, **176**, *pp.* 295–312, *Nov.* 1, 1940.—The effective cross-section for quenching of sodium resonance radiation by the saturated and unsaturated hydrocarbons, tertiary amines and several diatomic molecules, has been measured. The results indicate that with regard to quenching ability the gases fall into 2 groups, one comprising the saturated hydrocarbons and the inert gases and the other the unsaturated hydrocarbons and the amines. The difference in behaviour is too pronounced to be explained in terms of the discrepancy between the amount of energy the sodium atom gives up and the quenching molecule can receive but may be attributed to the presence of unsaturation in the molecule. Within any one series the number of atoms in the molecule apart from the unsaturated centre seems to have little influence on the quenching ability, and it has been concluded that the quenching ability may be regarded as proceeding from a centre of unsaturation. The results have been qualitatively considered in the light of Stern and Eyring's theory of non-adiabatic reactions. AUTHORS.

94. Quantum yields of some dye-sensitized photo-oxidations. F. HURD AND R. LIVINGSTON. *J. Phys. Chem.*, **44**, *pp.* 865–873, *Oct.*, 1940.—Quantum yields have been determined of the photo-oxidation of iodide ion by fluorescein, eosin, rose bengal, neutral red, phenosafranine, safranine T, indigodisulphonate and indigotetrasulphonate, and of the photo-oxidation of thiosulphate ion by eosin and neutral red. It has been shown that, within the limits of experimental error, there is no photo-sensitized oxidation of oxalic acid in the presence of rose bengal, neutral red, phenosafranine or methylene blue. A few observations on the sensitizing action of eosin and of methylene blue on the photo-oxidation of allythiourea, in acetone and methanol solutions, are described. AUTHORS.

95. Photovoltaic behaviour of pure silver bromide. H. L. SANDERS AND I. M. KOLTHOFF. *J. Phys. Chem.*, **44**, *pp.* 936–943, *Oct.*, 1940.—Pure silver bromide has been shown to exhibit a photovoltaic effect even in the absence of all free metal. This has been explained as due mainly to the potential-determining action of bromide ions liberated by light at the salt-solution interface. All previously reported photopotentials of silver/silver–halide electrodes are complex functions of the above effect, plus the oxidizing action of free halogen or hypohalite on the metal, and hence are almost impossible of exact interpretation or control. AUTHORS.

***96. Precision integrating sphere densitometer.** J. G. FRAYNE AND G. R. CRANE. *Rev. Sci. Instrum.*, **11**, *pp.* 350–355, *Nov.*, 1940.—An integrating sphere type of physical densitometer has been developed with a view to standardizing density measurements in the motion-picture industry. The instrument accommodates films or plates up to 5 in. wide. Scanning-beam dimensions of 0·025 in. × 0·100 in. are used but may readily be changed. Density values corresponding to (1) the equivalent of standard visual diffuse or (2) photographic printing density may be obtained by insertion of suitable optical filters. Densities up to 3·0 are read directly on a special 3-scale logarithmic meter which provides a uniform density scale. A chopper in the light path makes possible a.c. amplification using a highly stabilized amplifier with a highly selective gain-frequency characteristic. This latter feature permits operation in daylight or in a room illuminated with ordinary a.c. lamps. Calibration is based on the inverse square law. AUTHORS.

97. Extra-granular factors in photographic sensitivity. S. E. SHEPPARD AND C. L. GRAHAM.

Kodak Res. Lab. Commun. No. 177. *J. Franklin Inst.*, **230,** *pp.* 619–641, *Nov.*, 1940.—The attack of aqueous bromine solutions on silver sulphide is not favoured but rather slowed down by raising the *p*H of the solution, whether the silver sulphide be free or incorporated in gelatin. This is evidence against the view that silver sulphide is the chief halogen acceptor in the photographic reaction. It is, therefore, more probable that it is gelatin, which, in this rôle, induces the specific behaviour of the gelatino-silver halide emulsion in regard to *p*H, moisture, and *p*Br. The rather limited capacity for halogen acceptance in such emulsions, as evidenced by solarization, was adduced by Carroll and Hubbard as an argument against this view and favouring the silver sulphide hypothesis. But, as they themselves point out, this argument is not cogent, because the effective halogen-accepting power of the gelatin would be limited to the small amounts adsorbed to the silver halide grain, and which need to be supplemented by diffusible halogen acceptors to prevent solarization. AUTHORS.

REFLECTION, REFRACTION AND DISPERSION.

***98. Multi-purpose photo-electric reflectometer.** R. S. HUNTER. *Bur. Stand. J. Res., Wash.*, **25,** *pp.* 581–618, *Nov.*, 1940.—The instrument was developed primarily to measure apparent reflectance, specular gloss and trichromatic coefficients. These measurements are useful in the ceramic, paint, textile, paper and chemical industries to indicate lightness, gloss and colour of finished articles. In the reflectometer 2 light beams from a single source are directed along separate paths to 2 barrier-layer photocells. Various types of these photocells were studied to find which could be used most advantageously. The reflectometer employs a substitution null method and requires a galvanometer to indicate equality of the currents generated by the 2 photocells. For each sample tested there is a photometric adjustment to restore equality of the currents. The amounts of photometric adjustment are measured on the direct-reading scales, one of which is used for apparent reflectance and the other for specular gloss. AUTHOR.

99. Refractive index of shellac. G. N. BHATTACHARYA. *Indian J. Phys.*, **14,** *pp.* 237–246, *June*, 1940.—Refractive indices of various samples of shellac, lac constituents and a few other natural and synthetic resins, have been determined using the ordinary type of Abbé refractometer by a simple technique at different temperatures between 20° and 90° C. From the curves representing the variation of refractive indices of these with temperature their softening ranges have been found. The temperature coefficients are calculated for the linear portions of the curves. Houwink's observation, that the refractive index of shellac increases on polymerization by heat, is confirmed. AUTHOR.

100. Refractive index of silicate glasses as a function of composition. M. L. HUGGINS. *Commun. Kodak Res. Lab. No.* 770. *J. Opt. Soc. Amer.*, **30,** *pp.* 495–504, *Oct.*, 1940.—The refraction per g. atom of oxygen, defined by a formula of either the Gladstone-Dale, the Newton or the Lorentz-Lorenz type, equals the sum of terms characteristic of the component "metallic" elements, each of these terms being proportional to the number of atoms of that element per atom of oxygen. This is shown to be true (with but little error) for practically all classes of silicate glasses for which adequate data are available for testing the relationship. Deviations from strict proportionality are, however, observed for glasses containing large amounts of lead. Constants are derived empirically for use in the Gladstone-Dale and Newton type equations. Different constants are needed for triangularly surrounded and for tetrahedrally surrounded B atoms. AUTHOR.

101. Dispersion of magnetic double refraction in the short infra-red spectrum. F. J. DAVIS. *J. Opt. Soc. Amer.*, **30,** *pp.* 488–494, *Oct.*, 1940.—A study has been made of the infra-red dispersion of the magnetic double refraction—Cotton-Mouton effect—in the wavelength region from $\lambda = 0{\cdot}650\mu$ to $1{\cdot}6\mu$ of the following liquids: nitrobenzene, chlorobenzene, carbon disulphide, halowax oil, *o*-nitrotoluene, benzene and toluene. Ratios of the observed double refraction to the electric double refraction are shown to be constant within experimental error. Comparison of observed dispersion curves with calculated curves from Havelock's law is also shown to fit for the most part within experimental error. This indicates that the magnetic and optical anisotropies of the molecules are relatively independent of the wavelength. The deviation of Havelock's curve from the observed curves in general indicate that Havelock values for short wavelengths are too high, and for long wavelengths too low. The deviations shown for the liquids tried are greatest for benzene, where for long wavelengths the difference amounts to about 5 %. AUTHOR.

See also Abstracts 5, 117.

SPECTROSCOPY.

102. Arc spectrum of nitrogen. M. KAMIYAMA AND T. SUGIURA. *Sci. Pap. Inst. Phys. Chem. Res. Tokyo*, *No.* 982, *pp.* 479–487, *Aug.*, 1940.—A study is made of the nitrogen arc spectrum in the photographic infra-red, grating spectrograms with a dispersion of 28 Å/mm. being obtained. A list is given of all the lines observed and some of these are classified according to the transition involved. A. H.

103. Infra-red spectra of solid dicarboxylic acids. R. Fichter. *Helv. Phys. Acta*, **13**, 4, *pp.* 309–338, 1940. *In German.*—Infra-red absorption spectra between 700 and 3800 cm^{-1}. have been recorded for oxalic acid (dihydrate), malonic acid, succinic acid and *d*-tartaric acid in the solid state, a prism spectrometer with rock-salt and quartz prisms being employed. The thin solid films were prepared by crystallization on to rock-salt plates. All 4 substances give rise to a series of broad bands, many of which, with the help of the known Raman spectra, can be attributed to specific normal vibrations on group frequencies. Models with 2 and 3 atoms suffice for the interpretation. C. B. A.

104. Hydrogen bridging in cellulose as shown by infra-red absorption spectra. J. W. Ellis and J. Bath. *J. Amer. Chem. Soc.*, **62,** *pp.* 2859–2861, *Oct.*, 1940.—Observations of absorption bands characteristic of hydroxyl groups in the region 1·5 and 2·0μ have been made for cellulose. The extreme weakness of the band at 1·44μ and the failure to detect a band at 2·02μ indicate that, in natural cellulose fibres, relatively few unperturbed hydroxyl groups are present. The shifts toward longer wavelengths in the absorption bands in these two regions indicate the presence of OH vibrators which are perturbed through hydrogen bridging. However, in the natural arrangement of these extremely large molecules it appears that intermediate conditions of perturbation occur, corresponding to hydrogen bridges of variable distances and variable bond angles between the hydroxyl groups of the adjacent cellulose chains. Authors.

105. Absorption spectra of hydroxy-aldehydes, hydroxy-ketones, and their methyl ethers. R. A. Morton and A. L. Stubbs. *J. Chem. Soc.*, *pp.* 1347–1359, *Oct.*, 1940.—The ultra-violet absorption spectra of *o*-, *m*-, and *p*-hydroxy-aldehydes, hydroxy-ketones, and their methyl ethers, are described and discussed. The spectra are dominated by absorption maxima which are benzenoid in origin but show considerable displacements. Selective absorption undergoes second-order modifications when hydrogen-bond formation and interaction between hydroxylic solutes and polar solvents occur. Authors.

106. Flame spectrum of carbon monoxide. A. G. Gaydon. *Proc. Roy. Soc. A*, **176**, *pp.* 505–521, *Nov.* 27, 1940.—The spectrum of the flame of carbon monoxide burning in air and in oxygen at reduced pressure has been photographed on plates of high contrast. Greater detail has been obtained than has been recorded previously, and new measurements are given. The possible origin of the spectrum is discussed. The choice of emitter is limited to a polyatomic oxide of carbon, of which carbon dioxide is the most likely. The spectrum of the suboxide C_3O_2 shows some resemblance to the flame bands, but this molecule is improbable as the emitter on other grounds. A peroxide CO_3 is also a possibility, but no evidence for the presence of this has been obtained from experiments on the slow combustion of carbon monoxide. Carbon dioxide in gaseous or liquid form is transparent through the visible and quartz ultra-violet, and the flame bands are not obtained from CO_2 in discharge tubes. Comparison with the Schumann-Runge bands of oxygen shows that the flame bands may form part of the absorption-band system of CO_2 which is known to exist below 1700 Å if there is a big change in shape or size of the molecule in the two electronic states. The electronic energy levels of CO_2 are discussed. Since normal CO_2 is not built up from normal CO and oxygen, an electronic rearrangement of the CO_2 must occur after the combustion process. If the excited electronic state of CO_2 is triangular, then molecules formed during the combustion by transitions from this level to the ground state may be "vibrationally activated". This is probably the reason for many of the peculiarities of the combustion of carbon monoxide. Author.

107. Effect of molecular environment on absorption spectra of organic compounds in solution. I. Conjugated dienes. H. Booker, L. K. Evans and A. E. Gillam. *J. Chem. Soc.*, *pp.* 1453–1463, *Nov.*, 1940.—In view of the marked effect of variations in molecular environment on the location of the absorption band due to any particular chromophoric group, an attempt has been made to collect and to classify new and already published absorption-spectra data on conjugated dienes. The effect of various substituents has been studied and has been found to produce characteristic displacements of the absorption maximum, the location of which thus gives an indication of the type of diene present in any particular compound. The main sub-groups have been found to be acyclic dienes having 1, 2 or no cyclic substituents ; semicyclic dienes ; and mono-, di- and poly-cyclic dienes. In the last case, as has already been discovered in the sterol and the triterpene field, the arrangement of the conjugated system in 1 or in 2 rings, respectively, produces a marked difference in the location of the absorption maximum. Authors.

108. Infra-red absorption studies. XI. NH-N and NH-O bonds. A. M. Buswell, J. R. Downing and W. H. Rodebush. *J. Amer. Chem. Soc.*, **62**, *pp.* 2759–2765, *Oct.*, 1940.—[See Abstr.

459 (1940)]. Intermolecular NH–N bonds show a fundamental infra-red absorption near 3μ. These bonds are formed only when the first nitrogen is relatively much more acidic than the second nitrogen. NH–O bonds are formed only with a semipolar oxygen. The bonding observed by infra-red studies in amides and the peptide linkage is believed to be NH–O$^-$ with absorption near $3{\cdot}0\mu$ if isolated but at $3{\cdot}22\mu$ if the bonds are formed in pairs. A coplanar structure is postulated for the CONHR group which involves geometrical isomerism. This structure must be considered in any explanation of protein behaviour. AUTHORS.

***109. New method of standardization in spectrophotometry.** Y. ÖHMAN. *Stockholms Obs. Ann.*, **13**, 6, [16 *pp.*], 1940.—Details are given of a new type of filter (using the principle of interference of polarized light) which is of service for plate calibration. A 3 mm. quartz plate cut parallel to the principal axis is cemented between 2 polaroid plates. Using this, dark bands are produced across the spectrum and, since these are of uniform depth, they are of value for determining plate characteristics. One intensity distribution curve can be derived from the maxima and one from the minima. A. H.

110. Emission spectrum of antimony nitride. N. H. COY AND H. SPONER. *Phys. Rev.*, **58**, *pp.* 709–713, *Oct.* 15, 1940.—In a discharge through a mixture of N and Sb vapour a new band system has been found with the molecule SbN as carrier. The vibrational analysis yields the following formula for the heads: $\nu \pm 34465 + [830{\cdot}7(v' + \tfrac{1}{2}) - 6{\cdot}0(v' + \tfrac{1}{2})^2] - [942{\cdot}0(v'' + \tfrac{1}{2}) - 5{\cdot}6(v'' + \tfrac{1}{2})^2]$. A comparison is made with other molecules of the fifth group. AUTHORS.

111. Zeeman effects in arc spectrum of ruthenium. G. R. HARRISON AND J. R. MCNALLY, JR. *Phys. Rev.*, **58**, *pp.* 703–708, *Oct.* 15, 1940.—Measurements on resolved Zeeman patterns of 450 lines of normal Ru are reported. Five exposures to each polarized component of the light from a 4 A arc, operated in magnetic fields of intensity between 1 000 and 92 200 gauss, resulted in 85 plates which were measured on an automatic comparator. J and g values have been determined from the various patterns. The results obtained have been used to further the classification of Ru I, and to aid in the assignment of L and S values to highly perturbed terms. Though g values frequently depart strongly from values calculated from LS coupling, it is usually possible to assign meaningful L and S designations. Asymmetrical patterns in lines arising from the terms $y^5D_3{}^0$ and $y^5D_4{}^0$ are discussed. AUTHORS.

112. Raman spectra and hydroxyl frequencies of some fatty acids. B. D. SAKSENA. *Proc. Indian Acad. Sci. A*, **12**, *pp.* 312–320, *Sept.*, 1940.—Raman spectra of formic, acetic, dichloracetic and trichloracetic acids, are obtained with a filter of iodine in CCl_4 in order to record the O-H frequencies. Trichloracetic acid is also studied in different states of aggregation. The changes in the Raman spectra for various states are indicated by the change in the intensities of various lines, some being present in the solid only, others in solution only. The frequency 676 is sharp and strong in the solid, but weaker and more diffuse as we pass from the solid to the solution. The frequencies which vanish or become very weak on dilution represent the undissociated molecule, the frequencies which are strengthened on dilution represent the monomer, the frequencies which remain unaffected represent both the ion and the undissociated molecule while the frequencies which appear on great dilution represent the ionic frequencies. O–H bands have been recorded for all the acids; in the case of trichloracetic acid the band shows a triplet structure. The shift of the hydroxyl frequency from the normal value is greater in trichloracetic than in formic or acetic acid, which is in accordance with Venkateswaran's hypothesis. A. H.

113. Raman spectra and molecular structure of some aliphatic cyclic compounds. B. D. SAKSENA. *Proc. Indian Acad. Sci. A*, **12**, *pp.* 321–336, *Sept.*, 1940.—Raman spectra and polarization measurements have been obtained for cyclohexane, cyclohexanol, cyclohexanone, dioxane and paraldehyde. Several new frequencies have been observed in cyclohexanol and cyclohexanone. Polarization results show that, while cyclohexane exists in a purely *trans* form, dioxane exhibits a predominantly *trans* form with a small fraction of the *cis* form as well, weak lines being assigned to the *cis* form. Paraldehyde, cyclohexanol and cyclohexanone, show puckered structures. A lengthy theoretical discussion is given. A. H.

114. Raman spectrum of sugar. A. L. RAO. *Indian J. Phys.*, **14**, *pp.* 207–212, *June*, 1940.—By an improved method sugar was purified and the Raman spectrum of its solution taken. This revealed 16 Raman lines and the usual water band. Eight of the lines have been observed for the first time. A general assignment of frequencies as due to the C—C, C—O, C—H, δ (C—H) oscillations has been made. These lines are compared with those obtained with glucose and crystalline sucrose. AUTHOR.

***115. Vibration spectra of certain condensed gases at the temperature of liquid nitrogen. I. Experimental methods.** G. K. T. CONN, E. LEE AND

G. B. B. M. Sutherland. *Proc. Roy. Soc. A*, **176**, *pp*. 484–493, *Nov*. 27, 1940.—A description is given of experimental methods which have been developed for the investigation of infra-red and of Raman spectra at the temperature of liquid nitrogen. The infra-red spectrometer is essentially the Pfund-Barnes type, but it has been found possible to dispense with the fore-prism and to separate the overlapping orders from the grating by means of filter shutters. The spectrometer is used as a monochromator so that the radiation only enters the absorption cell after it has been through the diffraction train. The absorption cell has been designed so that it may be used for high as well as low temperatures. The apparatus for the Raman effect is a modification of that introduced by De Hemptinne, being especially suitable for the examination of small quantities of material. Authors.

116. Vibration spectra of certain condensed gases at the temperature of liquid nitrogen. II. The infra-red and Raman spectra of hydro- and deuterochloric acid. E. Lee, G. B. B. M. Sutherland and Cheng-Kai Wu. *Proc. Roy. Soc. A*, **176**, *pp*. 493–504, *Nov*. 27, 1940.—The results obtained agree in general with the earlier observations of Hettner and disagree with those of Shearin who reported discrete rotation lines. The doublet band observed by Hettner has been resolved into 2 separate bands with maxima at 2 701 and 2 744 cm^{-1}. and indications of a third band were obtained. Some fine structure very different from that reported by Shearin was observed on each of the two bands which were unsymmetrical in shape, being steeper on the l.f. side. The Raman spectrum was obtained at the same temperature and also showed a doublet structure in contrast to earlier observations at higher temperatures, which had given only a single line. The maxima of the Raman lines lay at 2 709 and 2 759cm^{-1}. The explanation of this doubling is to be sought in the manner in which the hydrochloric acid molecules associate in the solid state, since the alteration in the fundamental frequency from that found in the gaseous state shows that strong interaction must exist. The absorption due to the fundamental frequency of deuterochloric acid was observed under the same conditions. Here 3 maxima were obtained at 1 965, 1 982 and 1 992 cm^{-1}. and indications of more structure. These results show that the association of HCl and DCl molecules in the crystal below the transition temperature can probably take place in several different ways. Such a conclusion is in agreement with the X-ray investigations which revealed a symmetry so low that the crystalline structure could not be determined. Authors.

TRANSMISSION.

117. Transmission and reflection of plastics and metal blacks in the far infra-red. H. S. Seifert and H. M. Randall. *Rev. Sci. Instrum.*, **11**, *pp*. 365–368, *Nov*., 1940.—Transmissions and reflections have been measured at 9 wavelengths between 20·7μ and 152μ for a number of plastics and special surfaces. The residual rays from crystals were used as sources of approximately monochromatic radiation. The spectroscopy of the far infra-red depends primarily upon the use of absorbing filters and reflecting surfaces to obtain purity of spectra. Relatively few materials are suitable for these purposes and additional materials are greatly needed. Vacuum spectrographs and absorption cells require transparent windows capable of standing pressure. It is difficult to avoid using less than 4 such windows in any spectroscopic arrangement. If the transmission of the individual windows can be raised from 60 % to 80 % the transmission of the 4 is increased by a factor of more than 3. Similarly, it is a matter of importance that the absorbing material on the receiving surfaces of the thermopile be efficient in transforming incident radiant energy into heat. Authors.

X-RAYS.

118. Intense crystal reflections with small spacings. E. Ingelstam. *Ark. Mat. Astr. Fys.* **27*B***, 4, [4 *pp*.], 1940.—Curved-crystal spectrometers can be used both in reflection and transmission. The crystal face need not be a cleavage plane but may be obtained by grinding. It was not found necessary to etch the surface after grinding. The only disadvantage of such surfaces is a possible slight inclination of the surface to the crystal planes, which may affect the relative intensities of reflections of different order. Examples are given of crystal planes in quartz and in topaze which have small spacings but high intensities and are therefore suitable for analysing hard X-rays. R. P.

119. Calibration of X-ray developer. G. M. Busanovich. *Radiology*, **35**, *pp*. 407–412, *Oct*., 1940.—In order to make full use of the accuracy obtainable in taking X-ray exposures, similar accuracy in the development of the films is necessary. This paper describes a method of calibrating the developer by making use of 3 test exposures made with a graded Al filter. By subsequent development of strips from these test films, at various points during the life of the developer, it is possible to correct the development time so as to produce the same density and contrast as originally. In this way a calibration curve can be constructed in which development time is plotted against the number of films or area of film developed in the tank. A mean curve can be constructed from the results of 3 series of experiments and used subsequently to give the development time when the number of films developed by the tank is known. G. O. B.

See also Abstracts 17, 88.

HEAT.

CONDUCTION.

120. Simple application of the Laplace transformation. H. S. Carslaw. *Phil. Mag.*, **30**, *pp.* 414–417, *Nov.*, 1940.—The 2 problems in heat conduction solved recently by Tranter [Abstr. 194 (1940)], by a method involving the use of contour integrals, are now shown to be solvable by a more elementary method if use is made of the Laplace transformation. R. W. P.

121. Thermal conductivity of some sedimentary rocks. C. D. Niven. *Canad. J. Res. A*, **18**, *pp.* 132–137, *July*, 1940.—The thermal conductivity of some Canadian limestones and slate has been measured. The results are in satisfactory agreement with those of other experimenters, but there was evidence of changes in the stone, even at temperatures below 700° F. ; this vitiates the value, from a geophysical standpoint, of these and other determinations. Author.

See also Abstract 135.

CONVECTION.

122. Maintained convective motion in a fluid heated from below. A. Pellew and R. V. Southwell. *Proc. Roy. Soc. A*, **176**, *pp.* 312–343, *Nov.* 1, 1940.—This paper examines the stability in viscous liquid of a steady regime in which the temperature decreases with uniform gradient between a lower horizontal surface which is heated and an upper horizontal surface which is cooled. It is known that instability will occur at some critical value of $gh^3\Delta\rho/\rho k\nu$, h denoting the thickness of the fluid layer, $\Delta\rho/\rho$ the fractional excess of density in the fluid at the top as compared with the fluid at the bottom surface, k the diffusivity and ν the cinematic viscosity. The critical value depends upon the conditions at the top and bottom surfaces, which may be either "free" or constrained by rigid conducting surfaces. The theoretical problem is solved here under 3 distinct boundary conditions, and greater generality than before is maintained in regard to the "cell pattern" which occurs in plan. In addition, an approximate method is described and illustrated, depending on a stationary property akin to that of which Lord Rayleigh made wide application in vibration theory. Authors.

DILATATION.

123. Relative expansion of solids from absolute zero to their melting temperatures. A. Harasima. *Proc. Phys.-Math. Soc. Japan*, **22**, *pp.* 636–639, *Aug.*, 1940.—The relative expansion is calculated on the theory of fusion previously given by the author [Abstr. 2948 (1939)]. It is shown that the relative expansion between 0°K. and the melting point is given by $(10{\cdot}6/\Theta_D)\sqrt{(T_m/Mv^{2/3})}$ where T_m is the melting temperature in °K., M the atomic weight, v the molar volume and Θ_D Debye's characteristic temperature. The result agrees numerically with the result of Grüneisen's calculation. Author.

FUSION AND SOLIDIFICATION.

***124. New design of heat exchanger for liquefiers.** A. Goetz. *Rev. Sci. Instrum.*, **11**, *pp.* 394–395, *Nov.*, 1940.—A new design of Linde-type exchanger for a medium-size air liquefier is described, characterized by a simple and efficient spatial distribution of the high-pressure tubes in the low-pressure system, using for the latter rubber hose reinforced with canvas. The performance data of the exchanger are given. Author.

TEMPERATURE.

125. Flame temperature. B. Lewis and G. v. Elbe. *J. Appl. Phys.*, **11**, *pp.* 698–706, *Nov.*, 1940.—A general account of flame temperature measurement confined to flames produced by the combustion of fuels in furnaces and engines. The theoretical flame temperature corresponding to complete statistical equilibrium in the burned gas is distinguished from the experimental flame temperature measured by the gas law equation and corresponding to equilibrium in the translational degrees of freedom. The theory and technique of the line-reversal method are described as well as methods involving the use of wires and thermocouples. These methods can be applied to a particular zone of the flame. Use can also be made of brightness and absorption measurements within the infra-red, but here the temperature obtained is intermediate between the extreme values existing in the flame. Methods of determining the temperature and emissivity of sootforming luminous flames are described. An optical pyrometer can be used, the temperature being derived from spectral brightness measurements made through red and green filters. The difference between the experimental and theoretical temperatures should be negligible in industrial furnaces, but in combustion engines excitation lag is likely to exist, although confirmation by experiment has not yet been possible.

R. W. P.

THERMOCHEMISTRY.

126. Surface as limiting factor in slow combustion of hydrocarbons. R. G. W. Norrish and J. D. Reagh. *Proc. Roy. Soc. A*, **176**, *pp.* 429–448, *Nov.* 27, 1940.—With special reaction vessels, varying widely in diameter while maintaining approximately constant volume, and employing several refinements in technique, a study has been made of the effect of surface on the slow oxidation of several hydrocarbons, both saturated and unsaturated. When the diameter of the reaction vessel was sufficiently reduced, the reaction rate was observed to drop abruptly toward zero, while the corresponding induction period increased toward infinity. Data so obtained have demonstrated that in narrow vessels surface deactivation can predominate over other processes of deactivation, while in wider vessels surface and volume deactivation occur to a comparable extent over a considerable range of pressure. When the vessel diameter is decreased to a critical value, the surface deactivation almost alone can suppress the factors leading to chain branching, and from the reactions investigated the existence of such a critical diameter appears to be a general property of hydrocarbon oxidations in conformity with the theory of degenerate branching. Authors.

THERMODYNAMICS.

127. Geometrical note on van der Waals's equation. H. Bagchi. *Indian J. Phys.*, **14**, *pp.* 173–185, *June*, 1940.—The object of the paper is to study mathematically the (graphical) representation of van der Waals's equation in the (Euclidean) space of 3 dimensions. The investigations centre round the geometry of the resulting graph (Ω) and take account of the Cremona (or birational) transformations which convert Ω into a plane.

Author.

128. Entropies of large ions. The heat capacity, entropy and heat of solution of potassium chloroplatinate, tetramethylammonium iodide and uranyl nitrate hexahydrate. L. V. Coulter, K. S. Pitzer and W. M. Latimer. *J. Amer. Chem. Soc.*, **62**, pp. 2845–2851, *Oct.*, 1940.

See also Abstract 13

VAPORIZATION AND CONDENSATION.

129. Vapour pressures and boiling points of binary mixtures of hydrogen peroxide and water. P. A. Giguère and O. Maass. *Canad. J. Res. B*, **18**, *pp.* 181–193, *July*, 1940.—The total vapour pressures of binary mixtures of hydrogen peroxide and water have been measured by means of the static method at 30°, 45°, and 60° C. over the entire range of concentration. The vapour-pressure/composition curves have been found to exhibit large negative deviations from Raoult's law, but no minimum. A special apparatus and experimental technique were devised that enabled the composition of the vapour to be determined in each case. These data were used to obtain the partial pressures of both components. The values thus found are in good agreement with those calculated from the total vapour pressures by means of the Duhem-Margules equation. The activities of water and hydrogen peroxide in their solutions have been calculated and interpreted on the basis of the polarity of the two pure liquids. The normal boiling point and latent heat of vaporization of the solutions were obtained by extrapolation of the vapour-pressure data. Authors.

See also Abstract 13

ACOUSTICS.

130. New technique for determining ultrasonic velocities in liquids. R. L. Narasimhaiya and C. S. Doraiswami. *Indian J. Phys.*, **14**, *pp.* 187–189, *June*, 1940.—A method is developed for determining the ultrasonic velocity in liquids by obtaining simultaneously the diffraction pattern over the entire region of the visible spectrum using white light and a spectrograph. A superposed iron arc enables the diffracted angles to be computed for a number of standard wavelengths. The calculation of the angle involves the determination of the focal length of the camera lens for various wavelengths with its attendant errors ; but this difficulty has been overcome by obtaining on the same photographic plate the diffracted pattern from a grating, the number of lines per cm. of which is known. Knowing the ultrasonic frequency and the ratio of the displacements due to diffraction by the grating and by the liquid—a ratio constant at all wavelengths—the velocity of sound in the liquid is calculated. AUTHORS.

131. **Ultrasonics—a survey.** J. C. HUBBARD. *Amer. J. Phys.*, **8,** *pp.* 207–221, *Aug.*, 1940.

132. **Sound absorption in rectangular ducts.** L. L. BERANEK. *J. Acoust. Soc. Amer.*, **12,** *pp.* 228–231, *Oct.*, 1940.—A theoretical treatment of the attenuation of sound in ducts as given by Morse [Abstr. 4651 (1939)] is applied to Sabine's data [Abstr. 2018*B* (1940)]. The method of computation is given in detail. For small attenuations the P/A relation (perimeter/area) in Sabine's formula is valid for rectangular ducts not too far removed from being square. For all other cases accurate predetermination of the attenuation can only be achieved by using the exact theory. The attenuation is less for a rectangular duct of unequal transverse dimensions than for a square duct having the same P/A ratio. G. E. A.

*133. **Improved apparatus for direct measurement of absorption of sound in gases.** R. W. LEONARD. *Rev. Sci. Instrum.*, **11,** *pp.* 389–393, *Nov.*, 1940.—An improved apparatus has been tested with the highly absorptive gases CO_2 and N_2O. Measurements are made of the sound pressure by a microphone as it is moved away from a piston source vibrating in a large baffle. The resulting pressure distance/curves are recorded photographically and yield the absorption coefficient. Reflections from the walls of the cylindrical measuring chamber are reduced materially by specially designed glass baffles. The source is the end of a magnetostrictive rod driven by an improved Pierce-type oscillator with a frequency range of 11·3 to 112 kc./s. AUTHOR.

ELECTRICITY AND MAGNETISM.

CONDUCTION AND DISCHARGE IN GASES.

134. **High-temperature positive-column discharge tubes.** R. F. BARROW. *Proc. Phys. Soc. Lond.*, **53,** *pp.* 40–43, *Jan.*, 1941.—Two heavy-current positive-column discharge tubes for investigation of the emission spectra of refractory materials are described, together with details of their construction and mode of operation. The temperature necessary for the development of a convenient vapour pressure of the material under examination is attained by degradation of part of the energy of the positive column of the discharge, which is constricted in (i) at the narrow central portion of an all-silica tube, and in (ii) by a small axial hole through a sintered aluminium oxide cylinder, supported centrally in a silica envelope tube. AUTHOR.

CONDUCTION IN SOLIDS AND LIQUIDS.

135. **Thermal and electrical conductivities of metals and alloys.** W. F. CHUBB. *Phil. Mag.*, **30,** *pp.* 323–330, *Oct.*, 1940.—The evidence of the validity of the Wiedemann-Franz law is reviewed and the conclusion is drawn that the law does not hold accurately for all metals and for all temperatures. None of the empirical formulae which have been suggested to replace it represents the situation adequately. No account is taken of the results of modern electron theory on the limits of validity of the law and the deviations to be expected from it. R. P.

136. **Influence of solvent on formation of micelles in colloidal electrolytes. I. Electrical conductivities of sodium dodecyl sulphate in ethyl alcohol and water mixtures.** A. F. H. WARD. *Proc. Roy. Soc. A*, **176,** *pp.* 412–427, *Nov.* 1, 1940.—In very dilute solutions in water sodium dodecyl sulphate behaves as a completely dissociated electrolyte. Above a concentration $c = 00722_s$ the equivalent conductance (Λ) falls sharply and micelles are formed. To throw light on the mechanism of micelle formation, the variation of Λ with c has been measured in a series of mixtures of water and ethyl alcohol. Addition of alcohol decreases the tendency to form micelles. When there is 40% or more by weight of alcohol, micelles are no longer formed. The energy changes involved in micelle formation are calculated. Aggregation can occur if the interfacial energy available from the destruction of the paraffin-solvent interfaces of the ions is greater than the work to be done against electrical repulsion. The interfacial energy is no longer the greater beyond 40% of alcohol. It is shown that alcohol molecules are not in solution in the paraffin interior of the micelles in the mixed solvents, but are strongly adsorbed on the micelle surfaces. The influence of regions of lowered dielectric constant around the micelles is considered. AUTHOR.

137. **High-frequency resistance of superconducting tin.** H. LONDON. *Proc. Roy. Soc. A*, **176,** *pp.* 522–533, *Nov.* 27, 1940.—The h.f. resistance of tin in the superconducting state was measured at a wavelength of 20·5 cm. by a calorimetric method based on the principle of eddy-current heating. It was found that the resistance decreases gradually when the temperature falls below the

transition point, in contrast to the sudden drop in resistance peculiar to d.c. An explanation of such a behaviour is given based on the assumption of the simultaneous presence of normal and superconducting electrons. Good agreement between theory and experiment was found. Absolute measurements of the conductivity in the normal state at low temperatures with both h.f. and l.f. were carried out, and it was found that at the temperature of liquid helium the conductivity for h.f. is considerably lower than for l.f. This behaviour is possible due to the fact that the mean free path of the electrons becomes larger than the penetration depth due to skin effect under the conditions of high conductivity and high frequency. AUTHOR.

See also Abstract 151.

DIELECTRICS AND CAPACITANCE.

138. Electric moments of some substituted benzoic acids. C. S. BROOKS AND M. E. HOBBS. *J. Amer. Chem. Soc.*, **62,** *pp.* 2851–2854, *Oct.*, 1940.—A small discrepancy between the expected and observed values of *p*-chlorobenzoic acid and *p*-bromobenzoic acid is attributed to a resonance effect between the halogen and carboxyl groups substituted on the benzene ring. AUTHORS.

ELECTROCHEMISTRY.

139. Transport numbers of ZnCl$_2$ from e.m.f. measurements. A. C. HARRIS AND H. N. PARTON. *Trans. Faraday Soc.*, **36,** *pp.* 1139–1141, *Nov.*, 1940.—Measurements are reported of cells with and without liquid junction containing aqueous ZnCl$_2$ solutions from 0·5*m* to 12*m*. The activity coefficients and transport numbers of ZnCl$_2$ have been obtained.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

140. Inner excited states of proton and neutron. W. HEITLER AND S. T. MA. *Proc. Roy. Soc. A*, **176,** *pp.* 368–397, *Nov.* 1, 1940.—To avoid the difficulties of applying the present meson theory to the interaction of fast mesons with nuclear particles it is proposed as a hypothesis that the charge and spin of an electron can assume higher quantum states. The theory is developed and the possibility of observing the new particles discussed. AUTHORS.

141. Pair production by fast β-rays. H. BRADT, J. GUILLISSEN AND P. SCHERRER. *Helv. Phys., Acta*, **13,** 4, *pp.* 259–268, 1940. *In German.*—An attempt is made to observe the pair production by U*X* β-rays in lead, by means of the photons emitted in the annihilation of the positrons. It is known that in most cases 2 photons are emitted together, and that they will travel in opposite directions. Hence a coincidence counter arrangement is chosen in which the relative position of the counters can be altered. Coincidences observed when the counters are not diametrically opposite to each other cannot be due to annihilation of positrons. By this method it is found that the coincidences observed by Feather and Dunworth [Abstr. 3646 (1938)] cannot, in fact, be due to the annihilation. The number of positrons produced in Pb by a fast electron from U*X* is certainly less than $1{\cdot}2\times10^{-3}$. This upper limit is far below the figure found by other authors. R. P.

142. Scattering of 2·5 eMV neutrons in He. J. A. WHEELER AND H. H. BARSCHALL. *Phys. Rev.*, **58,** *pp.* 682–687, *Oct.* 15, 1940.—From the observations of Barschall and Kanner on the scattering of 2·5 eMV neutrons in He is deduced the existence at this energy of a coupling between the spin and the orbital motion of the neutron. Less clear-cut evidence points to appreciable interaction between a neutron and an α-particle of two units of mutual angular momentum, the classical distance of closest approach of which would be 7×10^{-13} cm. AUTHORS.

***143. Features of Geiger-Müller counters.** H. AOKI, A. NARIMATU AND M. SIOTANI. *Proc. Phys.-Math. Soc. Japan*, **22,** *pp.* 746–749, *Sept.*, 1940.—Characteristic curves and the shortest time interval between adjacent discharges of counters using alcohol vapour were measured for various series resistances. AUTHOR.

MAGNETISM AND ELECTROMAGNETISM.

144. Theory of approach to magnetic saturation. W. F. BROWN, JR. *Phys. Rev.*, **58,** *pp.* 736–743, *Oct.* 15, 1940.—The standard theoretical treatment of magnetization at high fields leads to a formula $J = J_s - b/H^2$; experimentally a term $-a/H$ is also found. In the standard treatment it is assumed that the internal forces responsible for the incompleteness of saturation are approximately uniform over distances containing a very large number of atoms. If these forces vary rapidly over shorter distances, the inter-atomic coupling forces prevent the direction of microscopic magnetization from varying with equal rapidity, and the $1/H^2$ law no longer follows. It is shown here that, for $H \gg 4\pi J_s$, point, line and plane concentrations of force lead to laws of the form $J = J_s - a/H^{n/2}$, with $n = 1$, 2 and 3, respectively. For $H \ll 4\pi J_s$ the law is of the same form but with different apparent values of J_s and a. For $H \simeq 4\pi J_s$ the behaviour is more complicated. The conclusion that the observed a/H term is due to line concentrations of force is supported by the dependence of *a* on degree of plastic strain, since the mechanism of plastic flow is believed to be a propagation of dislocation lines through the lattice. AUTHOR.

145. Mechanical model for the motion of electrons in a magnetic field. A. ROSE. *J. Appl. Phys.*, **11**, *pp.* 711–717, *Nov.*, 1940.—A mechanical model in the form of a gyroscope may be made to simulate the path of an electron in a uniform magnetic field acted upon by transverse electric fields. The uniform magnetic field is replaced by the spin velocity of the gyroscope, the electric fields are replaced by magnetic fields which give the same field configuration, and the electron is replaced by one pole of a permanent magnet mounted on the axis of the gyroscope. The spin velocity may be arbitrarily chosen for convenient observation. The path described by the magnetic pole under these conditions corresponds to the actual path of the electron. Structures for which electron paths have been observed and photographed are deflection plates in a uniform magnetic field, a diode in an axial magnetic field, and a split-anode magnetron. By periodically reversing the current through the field magnets it is possible to observe the effect of alternating electric fields. In one arrangement, in which the field was alternated in resonance with the revolution of the electron about the magnetic field lines, a path similar to that of charged particles in a cyclotron was obtained. AUTHOR.

146. Simple test of the inverse square law for magnetism. A. FERGUSON AND E. J. IRONS. *Proc. Phys. Soc. Lond.*, **53**, *pp.* 44–46, *Jan.*, 1941.—Assuming an inverse *n*th law, the expression for the intensity at points on the equatorial axis of the magnet, $M/(d^2+l^2)^{(n+1)/2}$, leads to a relation between the distance d from the centre of the deflecting magnet to the centre of the magnetometer needle, the angle of deflection θ and the ratio M/H, which is exact, irrespectively of the order of magnitude of l/d. Observed values of cot θ are plotted as abscissae with d^2 as ordinates, and by logarithmic transformation the graph is converted to a straight line of slope $2/(n+1)$. Even with simple apparatus the value $n=2{\cdot}00$ is obtained. Combining the results with those of an experiment by Töpler [*Ann. Phys.*, **21**, *p.* 158, 1884], a determination of M and H may be made by purely statical methods.

147. Adiabatic temperature changes accompanying the magnetization of ferromagnetic materials in low and moderate fields. L. F. BATES AND J. C. WESTON. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 5-34, *Jan.*, 1941.—A new and relatively simple method is described for the measurement of the heat changes which accompany magnetization processes in fields of the order of a few hundred oersteds. The adiabatic changes in temperature of a rod, which occur when the latter is taken step by step through a hysteresis cycle, are measured by a series of thermocouples of which the "hot" junctions are directly attached to the rod. The temperature-measuring system is capable of detecting changes in temperature of the order of 10^{-6} deg. C., and its sensitivity is such that 1 mm. scale deflection corresponds to the absorption or liberation of about 330 ergs/cm^3. in the specimen, deflections of 0·1 mm. being easy to read. Experiments made with pure annealed and hard-drawn Ni and with certain Ni-Fe alloys, strained and unstrained, are described, and many graphs are given to show the observed temperature changes as functions of the intensity of magnetization and of the applied field. The results provide a very effective proof of Warburg's law, but their main importance is that they enable a detailed analysis of the energy changes accompanying magnetization to be made. They show that Becker's views on magnetization processes in ordinary ferromagnetic materials are essentially correct, but do not support Preisach's conception of the formation of demagnetization nuclei in the case of extremely soft ferromagnetic materials. AUTHORS.

148. Gyromagnetic ratios for ferromagnetic substances: new determinations and a new discussion of earlier determinations. S. J. BARNETT. *Proc. Amer. Acad. Arts Sci.*, **73**, *pp.* 401–455, *July*, 1940.—All published determinations of the gyromagnetic ratio by means of the Barnett effect (magnetization by rotation) and of the Einstein and de Haas effect (rotation by magnetization), together with new measurements of the author, are critically reviewed. R. P.

See also Abstract 21.

MEDICAL RADIOLOGY AND ELECTROLOGY.

149. Physical characteristics of supervoltage X-rays. J. G. TRUMP AND R. W. CLOUD. *Amer. J. Roentgenol. and Radium Ther.*, **44**, *pp.* 615–618, *Oct.*, 1940.—Experimental data are given of dosage measurements of X-ray intensities at 10 cm. depth in relation to exciting voltages of X-rays, ranging from 300 to 1 400 kV. The intensity was measured in relation to the area of the field treated, the distance of treatment and the effect of back scattering. With increase of exciting voltage there is an increased depth dosage with decrease of scattering. At 1 200 kV excitation, with a distance of treatment of 70 cm. and a tube current of 0·5 mA, via a 10 × 10 cm. field, and filtration via 2 mm. Pb, 5 mm. Cu and 2 mm. Al, the output of the apparatus in question is 45 r./min., as measured by a standard thimble ionization chamber. B. J. L.

150. Measurements of the γ-radiation from radium by the free air ionization chamber. L. S. Taylor and G. Singer. *Amer. J. Roentgenol. and Radium Ther.*, **44,** *pp.* 428–443, *Sept.*, 1940.—The free air ionization chamber is an accepted standard for X-ray dosage generated at comparatively low voltages and, with modification, has been found suitable for X-rays generated up to 400 kV [Abstr. 1842 (1939)]. The present paper deals with the possible application of the method to γ-rays of radium of equivalent voltages from 600 to 2 000 kV and the further possible use with 1 400 kV X-ray apparatus, now under construction. The application of the free air chamber has been investigated with a large quantity of radium (0·5 g.), thus minimizing errors in respect of air pressure and chamber dimensions, lack of saturation, etc. Finally, the method is applied to evaluate the emission constants of radium in terms of Roentgens. The ionization chamber is described in detail. The method is found satisfactory if the air pressure is sufficient to give an effective free path equal to the longer-range recoil electrons. B. J. L.

PHOTO-ELECTRICITY.

151. Barrier-layer resistance of selenium photo-elements. A. E. Sandström. *Phil. Mag.*, **30,** *pp.* 428–429, *Nov.*, 1940.—The barrier-layer resistance is changed if the cell had been exposed to visible light shortly before observation, and by electric "shock". R. P.

***152. Direct-current amplifier employing negative feed-back for measuring stellar photo-electric currents.** Q. S. Heidelberg and W. A. Rense. *Rev. Sci. Instrum.*, **11,** *pp.* 386–388, *Nov.*, 1940.—A General Electric FP-54 electrometer valve is used in the input stage of the amplifier to give maximum sensitivity. The output voltage is fed back negatively into the input stage and the amplifier locks in a condition of equilibrium. In this condition the output voltage matches the input voltage with a tenacity proportional to the voltage gain of the amplifier before the feed-back is applied. A high-gain stage employing one type 1N5-G valve as a load for another type 1N5-G valve supplies a voltage gain of about 1500. The output stage uses a type 1C5-G valve connected as a triode. The output meter used is a Weston portable microammeter with full-scale deflection of 50 μA. A 1 900 Ω resistor is used in series with the meter to give full-scale deflection for 0·1 V. Thus, with an input resistance of 2×10^{10} Ω, a photo-electric current of 5×10^{-12} A gives full scale deflection. Authors.

THERMIONICS.

153. Thermal ionization of strontium. B. N. Srivastava. *Proc. Roy. Soc. A*, **176**, *pp.* 343–351, *Nov.* 1, 1940.—Experiments have been carried out at various temperatures and pressures of strontium vapour, and the equilibrium concentrations of Sr^+ and electrons inside the furnace have been obtained by allowing them to effuse through a narrow opening. From the results the equilibrium constant and the energy of ionization have been calculated. The results obtained agree, within the limits of experimental error, with the theory of thermal ionization and the known spectroscopic value of the ionization potential of strontium. Author.

154. Dielectric constant of an electronic medium at medium radio-frequency. S. R. Khastgir and C. Choudhury. *Indian J. Phys.*, **14,** *pp.* 213-229, *June*, 1940.—The variation of the dielectric constant of an electronic medium in the anode-screen-grid space of a Philips A 442 valve was investigated under various conditions for medium radio frequencies. The measurements of the effective dielectric constant were made by following the no-beat technique of a double heterodyne method. The effect of the conductivity of the medium was allowed for in estimating the effective dielectric constant of such a medium. The experimental results were found consistent with Lorentz's formula for the dielectric constant of a frictionless electronic medium after introducing a multiplying factor to obtain the effect of the time of stay of the electrons in the inter-electrode space. The multiplying factor was found independent of the wavelength of the measuring field and was found to depend only on the transit time. Authors.